Ontario

A Literature Review of Lake Trout Regulations in North America

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Preface

In 2002, the Ministry of Natural Resources embarked on a provincial exercise to review and streamline Ontario's fisheries regulations. This exercise had several components including a rationalization of fishing divisions, the development of regulatory "tool kits" for individual fish species, and an administrative clean-up of existing regulations. The development of tool kits for individual species was intended to ensure that regulations developed on a broad (i.e., landscape) level were based on the best science and information available and would ensure sustainability of the resource. These tool kits would then provide a standard approach (e.g., list of potential regulatory options) for the development of any new regulations in the future.

This literature review was conducted to assemble and consolidate background reference material for the development of the lake trout (*Salvelinus namaycush*) tool kit. Information has been assembled under ten general categories. Complete abstracts have been provided wherever possible. Where abstracts were not available (e.g., grey literature), an attempt has been made to summarize the key points of the study. In some cases, I was unable to obtain a copy of the document but have included the citation for future reference.

Finally, a synopsis of lake trout regulations from other North American jurisdictions has been assembled as an appendix to this literature review.

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Lake Trout Fisheries and Impacts of Angling

Anonymous. 1998. Squeers Lake: A partnership in lake trout research. Quetico-Mille Lacs Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Thunder Bay, Ontario.

In the winter of 1985 the Ontario Ministry of Natural Resources (OMNR) invited Thunder Bay and area anglers to participate in a research project involving the controlled harvest of lake trout from a small sanctuary lake (Squeers Lake) near Shebandowan (100 kilometres west of Thunder Bay). Fourteen years later fishing Squeers Lake has become an annual winter ritual for approximately 1000 lake trout anglers. These anglers have become partners in a long-term study to determine how many lake trout can be harvested from a lake trout population that feeds primarily on small fish, aquatic insects and other invertebrates.

Rather than harvesting the lake trout with a netting program the OMNR decided to invite anglers to catch the fish. For nine days each March angler's fish, eat hot dogs and chat with the OMNR fisheries specialists. The result is one of the highest profile lake trout studies in the province of Ontario and the collection of valuable research information useful in lake trout management.

Ball, H. 1991. Squeers Lake experimental lake trout fishery: Results and recommendations. Quetico-Mille Lacs Fishery Assessment Unit Report 1990-3. Ontario Ministry of Natural Resources. Thunder Bay, Ontario. 79 p.

Many small lakes in northern Ontario and Algonquin Region harbour polyphagous lake trout populations. Improved access to these lakes has resulted in increased fishing pressure and subsequent overharvest of lake trout. Managers often respond by creating fish sanctuaries to prevent the lake from being "fished out", resulting in a net loss of angling opportunities. The Squeers Lake experimental fishery is a part of an experimental management project and investigates the sustainable yield of lake trout. The project also evaluates the effectiveness of a pulse fishing strategy versus an annual harvest strategy for maintaining sustainable populations, while providing angling opportunities.

Results from the Squeers Lake project have contributed positively to the management and assessment of lake trout populations by:

1. Describing the population dynamics (growth, age and length structure, natural mortality, fecundity, food habits, biomass, and production) of polyphagous lake trout populations.
2. Educating the public (over 1000 anglers/year) about fisheries assessment and management.
3. Providing a creel census database to investigate the validity of standard creel survey design.
4. Validating and recommending ageing methods for lake trout.
5. Providing data to develop predictive yield models in the lake trout synthesis.

Impending results from this long-term project are:

- Estimation of the sustainable yield of polyphagous lake trout populations.
- Evaluation of a pulse fishing strategy versus an annual harvest strategy.
- Calibration of indicators of population health (ie. mean age, length and age at maturity, population size, fecundity, and mortality) relative to exploitation stress.
- Evaluation of lake trout stock-recruitment relationship.
- Development of predictive or formulative models relating yield, angler effort, and exploitation rate to determine population status in the absence of long-term data series.

Toward these ends, this report summarizes the results of the Squeers Lake fisheries assessment program, 1982-1989, and the experimental winter sport fishery, 1985-1989. The analysis of data found that yield increased from 0.6 kg/ha to 2.1 kg/ha between 1985 and 1989. The yield of male and female lake trout was variable but equal. The number if fish kept-per-angler ranged from 1.4 in 1986 and 1987 to 2.1 in 1985. Catch-per-unit-effort ranged from 0.125 in 1988 to 0.214 in 1985, but did not show any pattern of increase or decrease with time.

Fish greater than 46 cm had the highest exploitation rate in all years except 1988. Anglers harvested an increasing percentage of smaller fish, and the exploitation rate of small fish between 31 and 35 cm correspondingly increased between 1985 and 1989. Exploitation rate and yield increased proportionately with effort between 1985 and 1989 and the exploitation rate was positively related to yield. As effort increased from 4.7 to 20.5 rod-hours/ha, the exploitation rate increased from 5.0% to 12.8% between 1985 and 1989. The yield of lake trout increased with increasing effort and harvest, and has not shown any indication of reaching a plateau. If present rates of exploitation are maintained over a long period of time or they increased further, at some point yield will probably level off or decline.

Program objectives were achieved in 1990 but the ageing has not been completed for this report.

Ball, H. E. 1988. The dynamics of a polyphagous lake trout (*Salvelinus namaycush*) population in a northwestern Ontario lake. M. Sc. Thesis. Lakehead University. Thunder Bay, Ontario. 243 p.

Tagging studies, index gill netting, and an experimental winter fishery were used to investigate the dynamics of a polyphagous lake trout (*Salvelinus namaycush*) population in Squeers Lake of northwestern Ontario. The density and standing crop of mature lake trout in Squeers Lake is higher than reported for other lake trout populations. Lake trout in Squeers Lake exhibit a bimodal length distribution with a wide range in length at age, suggesting recruitment of juveniles into the adult population is regulated. Observed depth distribution of lake trout indicates adults may limit young juveniles to deep water. Exploitation in the 1970's may have produced several strong year classes, but recruitment into the adult population did not occur.

The Ricker yield model indicates Squeers Lake can withstand the removal of four to eight times the allowable yield of lake trout recommended by the

Morphoedaphic Index. This model accurately reflected the actual yield of the 1986 winter fishery.

The lottery system is useful for experimental management projects because it allows strict control and monitoring of effort and harvest. Anglers thought the lottery system was an unacceptable method for managing lake trout populations. Rotational pulse fishing appears to be a simple and acceptable system for managing polyphagous lake trout populations.

Barnes, L. E. 1982. Lake Manitou summer creel census, 1982. Manuscript Report. Ontario Ministry of Natural Resources, Espanola District. Espanola, Ontario.

During the period of May 21, 1982 to September 27, 1982, a roving creel census was conducted on the eastern basin of Lake Manitou. A total of 960 angling parties were contacted during the 75 sampling days. The estimated total fishing pressure for the season was 43,806 man hours. The average angling success during the study was 0.1219 lake trout-per-rod hour, which compares very favourably with other highly productive lake trout lakes. The estimated harvest of 0.89 kg/ha is also relatively high although it has dropped since 1979. As with recent studies on the lake, the catch consisted of about 6% native lake trout and 94% fish of hatchery origin.

Barnes, L. E., R. R. Claytor, and N. G. MacLean. 1984. The sport fisheries of Big Clear, Big Rideau, Big Salmon, and Devil Lakes, 1983. Rideau Lakes Fisheries Assessment Unit Report No. 8. Ontario Ministry of Natural Resources. Sharbot Lake, Ontario. 123 p.

In 1983, the Rideau Lakes Fisheries Assessment Unit conducted both a winter and summer creel census on Big Clear, Big Rideau, Big Salmon, Charleston and Devil Lakes.

The censuses were designed to provide baseline sport fishery information on these lake trout waters for trend-through-time analysis. Information requirements included:

- Estimates of catch, harvest, effort and angler success rates;
- Length, weight and age structures of the harvest;
- Contribution of hatchery origin fish to the harvest;
- Fishing methods; and
- User group characteristics.

Results were interpreted in light of several indices of overexploitation, i.e. relative yield, total mortality, Abrosov index and length-at-age.

These indices did not provide a clear-cut interpretation for any of the lakes. However, on the basis of 1981 to 1983 data, it appears that the lake trout populations in all five, study lakes are overexploited.

Generally, the majority of anglers during the winter lake trout season were locals while non-local Ontario residents and U. S. citizens predominated during the summer fishery.

The adequacy of our present sampling design was also examined. Doubling the sampling effort during season three on Charleston Lake in 1983 did not improve the precision of either effort or catch estimates.

Bernier, M. 1977. Bone Lake creel census, 1968-1976. Manuscript Report. Ontario Ministry of Natural Resources. Sault Ste. Marie, Ontario. 28 p.

The results of a nine-year winter creel census on Bone Lake are presented.

Catch statistics have shown wide fluctuations, while the fish population statistics have remained relatively stable during the survey period.

Bone Lake has provided an average of 12.37 man hours of fishing per acre, with a catch rate of 0.310 fish per hour. The estimated number of lake trout caught each year was 1,199 for a yield of 1.76 pounds per acre.

The fishery is maintained by age classes 4 and 5; the average size of the fish caught is 11.2 inches and less than one-half pound in weight. Most males first mature by age 3, while females do not reach maturity until age 5.

It was found that year class strength fluctuates widely and has a major effect on the fishery.

Berst, A. H. and G. R. Spangler. 1973. Lake Huron: The ecology of the fish community and man's effect on it. Technical Report No. 21. Great Lakes Fisheries Commission. Ann Arbor, Michigan. 41 p.

Lake Huron is a large, deep, oligotrophic lake, centrally located in the St. Lawrence Great Lakes system. Manitoulin Island and the Bruce Peninsula divide the lake into the relatively discrete water masses of the North Channel, Georgian Bay, and Lake Huron proper. Water quality in Lake Huron has deteriorated only slightly from the conditions which existed in the early 1800's. The only significant changes are confined to areas adjacent to centres of human activity, chiefly Saginaw Bay, and various harbours and estuaries in Georgian Bay and the North Channel. The lake has supported a commercial fishery which has produced annual catches as high as 13,000 metric tons. A dramatic decline in landings of commercially valuable species and an instability in fisheries resources has occurred in all areas of the lake since the 1940's. This depression of the populations of valued species was associated with the accidental introduction of the sea lamprey, instances of overfishing, and deterioration of water quality in Saginaw Bay. The present depressed state of the fisheries will undoubtedly persist until sea lamprey control is achieved and climax predators are re-established. Governments are proceeding toward the establishment of water quality criteria and fishery management practices which, hopefully, will stabilize the fisheries and prevent further deterioration of the aquatic environment.

Brown, R. 1981. Charleston Lake winter creel 1980. Manuscript Report. Ontario Ministry of Natural Resources. Brockville, Ontario.

Commencing with the opening of the 1980 lake trout season (Feb. 2, 1980) and continuing to the end of the same (Feb. 17, 1980), a creel census was conducted on Charleston Lake. The objective of this creel was to obtain information on angling pressure and harvest of lake trout from Charleston Lake.

During this survey period, 879 anglers were contacted, producing an observed harvest of 223 lake trout.

From pressure counts taken each morning, it was observed that weekend days, in conjunction with fishing derbies, produced an average of 213 persons per day as compared to only 59 persons per day on weekdays.

Winter fishing on Charleston Lake is practically non-existent prior to and after the lake trout season. During the lake trout season 99% of the angling pressure is on the lake trout population with very few whitefish, ling, or perch being taken while fishing for trout.

Due to the slow passing of the new 1980 lake trout season, angling for lake trout continued until the 27th of March, 1980, rather than the intended February 17, 1980 closure.

Angler checks, were not conducted during the extended season. Anglers were, however, contacted every third day and once each weekend by the writer.

The number of lines used by individual anglers on the lake was very interesting in that approximately 97% of the anglers used only one line rather than the legal limit of two lines.

The main method of fishing was jigging, both with and without natural baits (minnows) attached to the jigs.

Very few fishermen were happy with their success this winter, however, many expressed hope that the new split season would improve the fishery in the long run.

Although statistics were not taken, it would appear that about 80-90% of the fishermen were in favour of the split season. There was little talk about stocking rates not being high enough although those who did express an opinion were satisfied with the rates as they are now. Those against the split season were mostly concerned with "giving the fish over to the Americans" rather than losing the good spring fishing. They compared "the four months the Americans get while Ontario taxpayers only get 2 weeks". Numerous individuals suggested moving the winter season to the last two weeks in February.

Burris, K, K. Irwin, and J. Brisbane. 1985. A summary of an intensive winter creel census on six lakes in the Bancroft District, 1984. Fisheries Management Report 1985-02. Ontario Ministry of Natural Resources. Bancroft, Ontario.

An intensive winter creel census was conducted on 6 lakes in Bancroft District from January 1st to March 30th, 1984.

Five of the lakes selected for the creel census, Eels, St. Peter, L'Amable, Mephisto, and Papineau, are lake trout/bass lakes. The sixth lake, Jack Lake, is a walleye/bass/muskellunge lake.

A total of 1,038 lake trout anglers and 469 walleye anglers were interviewed during the study period. All of these lakes monitored had winter harvest estimates well below their estimated total allowable annual sustained yields.

Poor ice conditions throughout the first half of the study period may have significantly reduced fishing effort for the winter.

When 1983 creel census data from Jack and Eels Lake were combined with the 1983 winter creel values the harvest in both lakes were well above the allowable annual sustained yields.

Biological data from 156 lake trout and 75 walleye were collected and analyzed. The lake trout data indicated that winter anglers removed a large number of young (immature) fish. All of the lake trout lakes studied are stocked regularly with hatchery-reared lake trout. None of the lake trout sampled on Papineau Lake were hatchery-reared, indicating excellent natural recruitment. Hatchery-reared fish contributed significantly to angler success in all other lake trout study lakes.

Burris, K. 1985. A summary of a volunteer summer creel census on Silent Lake, 1983. Fisheries Management Report 1985-09. Ontario Ministry of Natural Resources. Bancroft, Ontario.

A volunteer summer creel census program was conducted on Silent Lake from June to September, 1983.

Anglers reported catching 38 lake trout during the creel period which translates into a harvest of 38.76 kg (0.34 kg/ha). The combined summer and winter lake trout harvest for 1983 of 69.98 kg (0.61 kg/ha) exceeds the estimated annual allowable sustainable yield. It is probable that the lake trout population was overharvested.

Hatchery-reared lake trout comprised 74% of the summer harvest and 50% of the winter harvest indicating that stocked fish contributed significantly to angler success.

The majority of the lake trout harvested by summer anglers were immature.

The majority of the summer anglers were Ontario residents and bass was the preferred target species.

Busch, D. 1979. Winter exploitation of the lake trout (*Salvelinus namaycush*) population of Hammell Lake, 1979. Manuscript Report. Ontario Ministry of Natural Resources. Red Lake, Ontario. 7 p.

Busch, D. 1982. Winter exploitation of the lake trout (*Salvelinus namaycush*) population of Hammell Lake, 1982. Manuscript Report. Ontario Ministry of Natural Resources. Red Lake, Ontario. 9 p.

Christie, W. J. 1974. Changes in the fish species composition of the Great Lakes. Journal of the Fisheries Research Board of Canada 31 : 827-854.

This paper is an interpretive review of the "case histories" which documented the changes in each of the Laurentian Great Lakes for the 1971 symposium on Salmonid Communities in Oligotrophic Lakes (SCOL). It suggests that Lakes Huron, Michigan, and Superior passed through a parallel series of stock changes after the invasions of those lakes by the sea lamprey. First, the lake trout and burbot stocks collapsed, and then with the relaxation of predation pressure rainbow smelt, deepwater cisco, and alewife stocks increased. Lake herring stocks collapsed in apparent response to the smelt increase. Whitefish were affected by sea lamprey, but recovery after the control of the lamprey in lakes Michigan and Superior suggested the exotic species had little influence. Lake Ontario differed from the other lakes in that it was inhabited by both sea lamprey and alewife before the turn of the century, and provided the reservoir from which these species expanded to colonize the upper lakes. Alewife apparently equilibrated early, but the evidence was that more recent perturbations allowed the sea lamprey to become a significant factor in the loss of the piscivores of Lake Ontario. Subsequent proliferation of ciscoes and smelt, and collapse of the herring, followed a sequence similar to that of the upper lakes. Lake Erie seemed to be similarly affected by loss of predator stocks, buts its predominantly eutrophic character made the situation more complex. Overfishing was indicated in many early stock collapses, in the early invasion of the smelt in Lakes Huron and Michigan, and in the recent cisco declines of Lakes Ontario and Huron. Eutrophication and more direct pollution stresses had mainly inshore impacts, but the similarity in the species sequencing in the oligotrophic Great Lakes suggested that although these factors may have supplemented the other effects, their influence before about 1950 was less than that of overfishing and the invasion of exotic species. Control of the sea lamprey, overfishing, and eutrophication seemed attainable in the Great Lakes, but the only defence against further invasions by pest species appeared to be maintenance of sufficiently dense piscivore stocks to assure their suppression. Determining the levels of harvest appropriate to this provision will require intensified research.

Clark, R. D., Jr. and B. Huang. 1985. Conflict between sportfishing, commercial fishing, and rehabilitation of lake trout in Lake Michigan. North American Journal of Fisheries Management 5(2B) : 261-276.

Hatchery-reared lake trout (*Salvelinus namaycush*) have been planted annually in Lake Michigan since the mid-1960s in an attempt to rehabilitate stocks that were completely exterminated in the mid-1950s. These planted fish now support both sport and commercial fishing but have failed to reproduce successfully. One concern is that the level of fishing has increased to the point of threatening the goal of rehabilitating the stocks. We developed a mathematical simulation model to study the interactions between sport fishing, commercial fishing, and rehabilitation. The model was derived from a conventional dynamic pool model but contains additional features that allow the analyst to simulate the planting of

numbers of yearling fish each year, compute the individual yields for sport and commercial fishing groups who compete simultaneously for the same stock, apply a handling mortality factor for sub-legal fish caught and released, and compute the number of fish remaining in the stock along with their annual egg production. Our assessment focused on the effect of exploitation by one fishing group, on the yield of the other fishing group, and on the effect of all fishing on the egg production of the stock. The lake trout population in the Frankfort-Good Harbor Bay area of the lake was used as a case study. The instantaneous fishing mortality for the sport fishery was 0.15 from 1972 to 1975 and 0.22 from 1976 to 1978. The commercial fishery began in 1979, and the combined fishing rate for sport and commercial fishing was 0.42 from 1979 to 1981. Mail survey estimates showed a decline in sport catch of 50% from 1978 to 1981 while sport fishing effort remained relatively constant. The model analysis showed that competition from the commercial fishery was the most likely reason for this decline in sport catch. If the combined fishing mortality rate remains at 0.42, egg production will decrease from a high of 45 million in 1978 to 20 million during the 1980s. Tests of different fishing regulations showed that egg production could not be substantially improved by imposing catch restrictions on one fishing group and not the other. Many of the fish protected did not survive to reproduce but were caught by the unrestricted fishing group. Joint regulations benefited egg production a great deal, but the restrictions necessary for successful rehabilitation were severe. The survival rate of lake trout in their first year of life was unknown, but simulations were conducted for selected management schemes using a reasonable range of survival rates from 0.5 to 0.005. The rehabilitation goal was defined as the production of 25,000 wild fish of age 4, the approximate number now produced by stocking. Only the complete closure of both the sport and commercial fisheries allowed this goal to be achieved in less than 25 years for the entire range of first-year survival rates. If the first year survival rate was as high as 0.01, the goal was reached in less than 25 years when a slot limit of 711 mm was imposed on both fisheries and current stocking rates were maintained. It was also reached in less than 25 years when a 660 mm size limit was imposed on both fisheries and the stocking rate was doubled. If the first-year survival rate was 0.05, the rehabilitation goal was reached within 5 years, even if no regulations were applied to either fishery. However, such a high survival rate probably is too optimistic.

Claytor, R. R., A. Mathers and N. G. MacLean. 1985. The winter sport fisheries of Big Clear, Big Rideau, Big Salmon, Charleston and Devil Lakes, 1984. Rideau Lakes Fisheries Assessment Unit Report No. 13. Ontario Ministry of Natural Resources. Sharbot Lake, Ontario. 74 p.

In February 1984 the Rideau Lakes Fisheries Assessment Unit conducted a creel census on Big Clear, Big Rideau, Big Salmon, Charleston, and Devil lakes. The census was part of a longterm program designed to provide sport fishery information on these lake trout waters for trend-through-time analysis. Information requirements included:

- Estimates of catch, harvest, effort and angler success rates;
- Length, weight and age structures of the harvest;
- Contribution of hatchery origin fish to the harvest;

- Fishing methods; and
- User group characteristics.

Results were interpreted in light of several indices of overexploitation, i.e. relative yield, total mortality, Abrosov index and length-at-age.

These indices did not provide a clear-cut interpretation for any of the lakes, however, the lake trout populations in all lakes showed signs of overexploitation.

Increases in CUE and yield indicate that the lake trout fishery in Big Clear Lake is recovering from prior overexploitation. However, the continued decline of the Abrosov index and the increase of angler effort suggest that the increase will be short lived.

In Big Rideau Lake, trends in yield and CUE indicate that the lake trout fishery is relatively stable at present and stocking rates and is one of the intermediate stages of development.

The decline in mortality and the increases in yield and CUE suggest that the lake trout population in Big Salmon Lake is recovering from past overexploitation. However it is difficult to assess this population without a better understanding of the summer fishery.

In Charleston Lake the lake trout fishery seems to be stable at present stocking and effort rates, however, apparent declines in CUE warrant close monitoring.

The summer fishery is very important in Devil Lake, however, the winter data seems to indicate that the trout population is in the late intermediate stage of development.

Data from Big Clear and Devil Lakes showed that lake trout caught on herring bait were significantly larger than trout caught on other baits.

The majority of anglers were local residents of Ontario.

Coble, D. W., R. E. Bruesewitz, T. W. Fratt, and J. W. Scheirer. 1990. Lake trout, sea lampreys, and overfishing in the upper Great Lakes: A review and re-analysis. Transactions of the American Fisheries Society 119(6) : 985-995.

To assess the role of commercial fishing in the destruction of lake trout (*Salvelinus namaycush*) in Lakes Huron, Michigan, and Superior in the 1940s and 1950s, we reviewed the literature and analyzed catch and effort data for U.S. waters by regression analysis. There is abundant evidence of the effect of the sea lamprey (*Petromyzon marinus*) in the destruction of lake trout, but some have claimed that fishing was also influential. We considered that a persistent, significant decrease in catch-per-unit-of-effort before and in the first few years after the sea lamprey was first found in a lake would be evidence of overfishing. We found no convincing evidence of overfishing in Lakes Huron and Michigan. Lake trout probably were overfished in Lake Superior before the sea lamprey

became a major influence. We conclude that statements that lake trout were destroyed in Lake Huron or Lake Michigan by a combination of overfishing and the sea lamprey are not justified. The same claim applied simply to the Great Lakes is ambiguous, for it may be construed that lake trout were overfished in all the lakes. More critical analysis of evidence for our beliefs and hypotheses is recommended.

Cordone, A. J. and T. C. Frantz. 1966. The Lake Tahoe sport fishery. California Fish and Game 52(4) : 240-274.

Lake Tahoe is a deep, cold, extremely oligotrophic lake located in the Sierra Nevada of California and Nevada. Tahoe anglers can be divided into four distinct categories: topline, deepline, shore and pier anglers. These groups had dissimilar success rates and catch compositions. In terms of the lake's natural fishery, deepliners had the highest and most consistent success and caught lake trout almost exclusively. Topline success was next, with the catch composed primarily of rainbow trout, followed by lake trout, then brown trout. Pier anglers were the next most successful group who took mostly wild rainbow trout, followed by mountain whitefish. Least successful were the shore anglers, who caught mostly wild rainbow trout. Planted trout increased success rates substantially, benefiting largely the shore and pier anglers and to some extent the topliners. The lake trout was the dominant game fish in the catch, comprising about 70% by number of all wild trout. Lake trout averaged 18.5 inches in fork length. Largest specimens were taken in the winter, intermediate sizes in the summer, and smallest ones in October. Estimated lake trout yield was about 0.24 pounds-per-acre-per-year. A stable lake trout fishery is indicated and no changes in angling regulations are recommended. Some evidence indicates that Lake Tahoe under present conditions may be close to its potential game fish yield. On the other hand, it is possible that the yield may be increased; e.g., by more efficient utilization of potential productivity of the limnetic zone by an open-water game fish.

Diebolt, J. 1982. Lake Manitou creel census, 1982. Manuscript Report. Ontario Ministry of Natural Resources. Espanola, Ontario.

A total of 1716 anglers were observed during the 1982 winter creel census on Lake Manitou. They had angled for 3,453 hours and caught 682 lake trout. Fourteen or 0.02% of this catch were assumed to be native lake trout. Catch-per-unit-effort was calculated to be 0.16 fish per rod-hour for the lake as a whole.

Calculations of total pressure and harvest revealed that 18,318 anglers fished for 39,213 hours and caught 7,738 lake trout. Of the total number of anglers observed, 233 were located in the west basin of Lake Manitou. They angled for 392 hours and caught 24 lake trout. Catch-per-unit-effort was calculated at 0.10 fish-per-rod hour for the west basin. Catch-per-unit-effort for the east basin was calculated at 0.22 fish-per-rod hour.

Desjardine, R. L. and J. N. Lawrence. 1979. Winter creel census on Lake Simcoe, 1979. Lake Simcoe Fisheries Assessment Report 79-6. Ontario Ministry of Natural Resources. Sutton, Ontario.

During the winter of 1979 it was estimated from creel census results that 98,604 anglers spent 583,270 hours to catch 8,834 lake whitefish (*Coregonus clupeaformis*), 5,329 lake trout (*Salvelinus namaycush*), 222,715 lake herring (*Coregonus artedii*), 233,306 yellow perch (*Perca flavescens)* and 83,634 rainbow smelt (*Osmerus mordax*). Overall catch-per-unit-effort (CUE) was 0.98 fish-per-angling hour. CUE improved throughout the angling period and CUE was consistently higher for weekday over weekend fishermen. Most anglers were residents of Ontario (91.5%). Winter angling parties averaged 2.1 people, 1.3 lines were used per fisherman and 3.7 fish were caught per person. Angler preferences included herring (47.7%), lake whitefish (34.1%) and lake trout (33.6%), with about half the anglers seeking two or more species. Age and length data for angler-caught lake trout, lake whitefish, herring and yellow perch are provided. Anglers continued to harvest old whitefish from the residual population and hatchery-reared fish predominated in the lake trout catches (76.4%). Lake herring and yellow perch continue to dominate winter catches.

Duckworth, G. A. 1982. Lake Temagami and Cross Lake summer creel census report 1981, including an assessment of the annual lake trout fishery on Lake Temagami. Ontario Ministry of Natural Resources, Temagami District. Manuscript Report. 90 p.

Eason, G. 1980. The lake trout fishery of Hawley Lake. Ontario Ministry of Natural Resources. Moosonee, Ontario. 106 p.

Through the analysis of data it appears that the lake trout population of Hawley Lake is being overharvested. Using the yield estimate based on a depressed population there would be an overharvest of 356 lake trout (519 kg or 0.43 kg/ha) in a normal harvest year and 133 lake trout, (193 kg or 0.16 kg/ha) in a year of minimum harvest. Even at the estimated maximum sustainable yield, there would be an overharvest of 275 lake trout (413 kg or 0.34 kg/ha) in a normal year and 52 lake trout (87 kg or 0.07 kg/ha) in a year of minimum harvest. The problem is to accurately determine the present harvest because we have only one harvest census in the 1970s and there has never been a complete census for the month of June.

Continuing decline of the population is indicated by:

- The decline in catch-per-unit-effort in relation to effort;
- The smaller lake trout component in the catch;
- The compressed age, length and weight distributions;
- The high mortality rate;
- The increased growth rates;
- And probably by the recent decline in catch, releases, and effort, the imbalanced sex ratio, and apparently improved food habits.

If the present trend continues, the stock will eventually dwindle away to nothing. In the interim, year class failures will probably become more frequent and pronounced as the fishery relies on fewer age classes. Even more serious is a hypothesis that a large adult lake trout population is necessary to control the aquatic community (perhaps through predation on other fish which reduces the

competition for the young lake trout). If the adult segment of the population is reduced to a certain point the lake trout can no longer control the system, the population collapses and is unable to recover. The data indicate that the Hawley Lake population is continuing to decline, and is therefore in danger of reaching this critical point. The point of collapse cannot be predicted but may be imminent, considering that the Great Slave Lake population collapsed without warning after 120 years of fishing during which the yield exceeded 0.5 kg/ha in only one year.

The regulations necessary to protect the lake trout in Hawley Lake depend on: (1) allowable yield, (2) the harvest pressure on the population; and (3) the harvest strategy chosen by the natives.

From the background information, it appears that the population in its present state can support a yield of about 270 lake trout per year. If the trends in the 1977 harvest data continue, the current harvest pressure should be about 250 lake trout per-year by fly-in anglers and about 225 lake trout per-year by the natives. With these assumptions, the following regulations for each harvest strategy should protect the population.

Three strategies are suggested to reduce the pressure on the Hawley Lake fishery. The first strategy allows the native people subsistence harvest and regulates the harvest by fly-in anglers. The second strategy calls for the reduction in both native and fly-in angler harvest. The third and final strategy would require the abandonment of the native gill-net subsistence fishery altogether, the harvest of the fly-in fishery is slightly less which would allow the stock to begin to rebuild, in this case the native fishery could again be slowly introduced on a smaller scale.

Regulations involved in these strategies are as follows:

- Lake trout possession limit could be reduced to 1 fish per angler
- Lake trout season could be severely reduced to perhaps the last two weeks in July. This would reduce the number of angler days.
- Lake trout season could be opened every other year for perhaps the entire month of July, assuming 90 angler days in the month with some rescheduling.
- The lake trout season could be closed until the population recovers to the point where the maximum yield of 350 lake trout-per-year can be taken. It would probably take about four years for unexploited year classes to dominate the fishery.
- Net length in the native gill-net fishery could be reduced if all other factors remain equal.
- Netting in the lake could be restricted to about 2 weeks in June or July.
- Net length could be reduced by a smaller amount, perhaps 1/3.
- Lake trout possession could be reduced to 2 fish-per-angler. The creel census data suggests that this would reduce the catch by about 50 to 65 lake trout.
- The open season for lake trout could be reduced to June 15 to August 15 approximately. This should reduce the catch to about 200. Combined with

the catch limit, this should bring the catch close to 170, assuming that so9me anglers reschedule their trips.

The following general restrictions should also be adopted to help protect the population:

- Natural bait should be prohibited to reduce the amount of hook swallowing and allow more fish to be released unharmed. This would also prevent the introduction of non-native species which could disrupt the aquatic community.
- The tourist camps should also be licenced for a fixed number of guests and be prevented from expanding.
- Fly-in anglers could be required to hire a guide. This would improve business for the fish camps and help to offset any reduction in income caused by increased restrictions on angling or the subsistence fishery.

Ellrott, B. J. and J. E. Marsden. 2001. Status of the lake trout in Lake Champlain. p. 36-36 *In* Great Lakes Science, Making it Relevant: Abstracts from the 44th Conference on Great Lakes Research, June 10-14, 2001. International Association for Great Lakes Research. Green Bay, Wisconsin.

Lake Champlain once supported self-sustaining populations of lake trout. Over-harvest, predation on young trout, and parasitism by sea lamprey (*Petromyzon marinus*) were critical in the population crash and eventual extirpation that occurred around 1900. Intensive stocking began in 1972 and by 1999 nearly five million lake trout were stocked mostly as spring yearlings. An experimental sea lamprey control program began in 1990 to reduce sport-fish mortality.

Eshenroder, R. L. 1987. Socio-economic aspects of lake trout rehabilitation in the Great Lakes. Transactions of the American Fisheries Society 116 : 309-313.

During the 1940s and 1950s, the major fisheries for lake trout (*Salvelinus namaycush*) in the Great Lakes declined precipitously because of predation by sea lampreys (*Petromyzon marinus*) and overfishing. The need to control the sea lamprey and rehabilitate lake trout resulted in the establishment of institutional arrangements among the responsible state, provincial, and federal fishery agencies. The early arrangements were various committees that coordinated fishery investigations and sea lamprey control during the 1940s and 1950s. These committees were eventually replaced by the Great Lakes Fishery Commission, which was established in 1955 and remains the single coordinating body for fishery activities on the Great Lakes. Because most management agencies believe that lake trout return greater economic benefits in the sport rather than the commercial fishery, the catch in most areas is allocated exclusively to anglers. However, lake trout sport fisheries have recently come under more restrictive regulations, which have been opposed by some client groups such as the charter boat fishery. In the future, more public input is needed in decision processes that consider desirable mixes of salmonines and their prey for the Great Lakes. Because lake trout carry greater body burdens of contaminants than do other salmonines in,the Great Lakes, a controversy exists as to how vigorously lake trout rehabilitation should be pursued when other species could be stocked in their place.

Evans, D. O., J. M. Casselman, and C. C. Wilcox. 1991. Effects of exploitation, loss of nursery habitat, and stocking on the dynamics and productivity of lake trout populations in Ontario lakes. Response to Stress Working Group, Lake Trout Synthesis. Ontario Ministry of Natural Resources. Toronto, Ontario. 188 p.

We employed creel survey information, lake survey information, fisheries assessment data, and population modelling to evaluate the effects of angling exploitation, loss of deep-water nursery habitat, and stocking of hatchery-reared, non-native stocks of lake trout (*Salvelinus namaycush*) on the dynamics of lake trout populations in Ontario lakes. Variation in lake trout harvests between lakes is primarily caused by differences in fishing effort and lake size, but season, lake productivity and habitat quality also have significant effects. Yields of lake trout in many Ontario lakes appear to be well in excess of the natural production capacity to sustain them, especially for winter fisheries on small lakes. In these cases, yields are often maintained by stocking of hatchery-reared fish, although harvest-per-unit-effort (HUE) is generally lower for populations supplemented by stocking than for self-sustaining wild populations. Fishing intensity and yield are highest on small lakes, but they also receive the highest stocking rates. Stocked lakes generally had less and lower quality habitat for lake trout than lakes supporting strong self-sustaining stocks, suggesting greater sensitivity of the former to overexploitation and other stressors. Angling pressure on lake trout was greatest during winter, winter fishing intensity being about 25% greater than spring and summer combined. Winter yield was similar to the yield for the entire open-water season, varying from about 1.16 $kg \cdot ha^{-1}$ for 100 ha lakes to about 0.10 $kg \cdot ha^{-1}$ for 10,000 ha lakes. Reductions in winter harvests appear to be required on lakes of about 1000 ha and less, if self-sustaining stocks are to be maintained. The relationship between yield and fishing intensity was similar during all seasons and provided a useful format for comparison of exploitation levels between lakes and for obtaining an assessment of the relative status of lake trout fisheries. Lake area was a good predictor of fishing effort, but a weak predictor of harvests, the latter varying by 1-2 orders of magnitude for lakes of the same surface area. Harvest-per-unit-effort (HUE) in number of fish was inversely related to lake area for winter fisheries, despite higher fishing intensity in small lakes. HUE (kg) was positively related to lake area for open-water and annual fisheries. These results suggest either higher production or higher vulnerability of lake trout in small lakes during winter and reflect larger body sizes of lake trout in large lakes which are more heavily fished during open-water seasons. Use of two rods per angler during winter appears to cause a significant increase in harvest per angler. This effect is greatest on small lakes.

Population modelling revealed marked sensitivity of lake trout populations to the combined effects of exploitation and reductions in early survival, exploitation being much more damaging to populations having weak early survival. Protection of early life habitats, therefore, is extremely critical for maintenance of angling yields of self-sustaining lake trout populations. The population model also revealed the lengthy response times, in the order of decades, of lake trout populations to chronic degradation and conversely to rehabilitative measures, both of which clearly emphasize the benefits of effective fisheries assessment and conservation management of natural self-sustaining stocks.

Stocking tends to stimulate fishing which, in turn, can result in displacement of the local native stock by the hatchery stock. Modelling revealed that stocking of non-native trout, on wild populations subject to high exploitation, caused transformation of the genetic composition of the extant populations, even when the stocked fish did not reproduce or interbreed with the native fish. Our model predicted that, at high exploitation and stocking rates presently seen in many Ontario lakes, the wild stocks would be replaced by the hatchery stock within a few generations. Widespread stocking of a few domesticated non-native stocks, therefore, appears to pose a serious risk to the genetic diversity of the species. We recommend a moratorium on widespread supplemental stocking of self-sustaining wild stocks. We also recommend that greater emphasis be placed on management for self-sustaining status of the lake trout resource. The best way to achieve this objective is through regulation of exploitation to allow adequate spawning escapement combined with habitat conservation and rehabilitation.

Fruetel, M. 1996. The Squeers Lake Experimental Winter Fishery. FAU Update No. 96-1. Quetico-Mille Lacs Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Thunder Bay, Ontario. 2 p.

Since1985, the Quetico-Mille Lacs Fisheries Assessment Unit has organized an experimental winter fishery for lake trout (*Salvelinus namaycush*) on Squeers Lake, a 384 ha lake located about 100 km west of Thunder Bay. The lake receives angling pressure for only nine days annually during the latter half of March. A lottery is held to select the appropriate number of anglers required to meet that year's effort and harvest target. All anglers are required to check in with the creel survey crew and to complete a diary describing their fishing effort and catch. All fish harvested must be submitted for sampling.

The question of what is the sustainable yield remains unanswered and will likely require another generation of study. The fish we harvest now are a result of the "healthy" population that spawned in the early 1990s. To determine the sustainable yield we need to monitor the ability of the 1993-1996 year-classes to provide a fishery in the future. Despite large changes in the adult population size, no overt signs of overexploitation have been detected that that have affected the winter fishery. Catch rates remain high, recruitment to the fishable population is good, and mortality estimates are within the acceptable range. However, creel survey data show a decrease in average size in 1996, changes in the mean and modal age since 1993, and a growth response. Indicators such as CUE that we typically rely upon to signal population change have been insensitive to changes in mean and modal age and have provided no warning of the magnitude of change observed in the Squeers Lake spawning population.

Fry, F. E. J. 1939. A comparative study of lake trout fisheries in Algonquin Park, Ontario. University of Toronto Study Biological Series 46, Ontario Fisheries Research Laboratory Publication 58 : 69 p.

Fry, F. E. J. 1949. Statistics of a lake trout fishery. Biometrics 5(1) : 27-67.

Since 1936 the lake trout fishery of Lake Opeongo, Algonquin Park, Ontario, has been followed by a means of creel census. This census was undertaken as an experiment in methodology as well as to give information on the lake trout

(*Cristivomer namaycush*). Thus one of the main objectives has been to determine to what extent a record of fish caught, and of the circumstances surrounding their capture can yield a picture of the nature of the population under exploitation and of the changes that may take place in it.

In this report the growth rate, age composition and fecundity are related to the statistics of catch with the express aim of building up from these data some logical picture of the lake trout population from which this fishery was drawn. Thus the object is to determine within whatever limits it may be possible to attain, the size of population, its annual increment weight, its spawning strength and the degree to which the fishery exploits it.

Fry, F. E. J. and V. B. Chapman. 1945. The lake trout fishery in Algonquin Park from 1936 to 1945. Transactions of the American Fisheries Society 75 : 19-35.

The average lengths of lake trout (*Cristovomer namaycush*) captured in the various Algonquin Parks lakes during the decade varied from 13.3 to 24.8 inches and the number captured-per-100 boat-hours from 39 to 154. When the average length of fish captured is plotted against number captured per-unit-effort, all the points fall below a line which begins at a length of 13.3 inches with an availability of 220, rises to an availability of 355 at 15.5 inches, and drops lower as the size increases until at 24 inches the line falls below 100 fish per hour. This line has been taken as the standard for availability of lake tout in Algonquin Park and a fishing index has been proposed which compares each fishery with this standard curve. Certain lakes have shown marked annual fluctuations in size and abundance of lake trout that suggest the progression of major year classes through the fisheries. More detailed examination of the catch statistics indicates that an extremely uneven success of year classes of lake trout appears to be universal in the Algonquin Park lakes.

Gillap, D. 1983. A summary of a voluntary summer creel census, Silent Lake, June – September, 1982. Fisheries Management Report 1983-06. Ontario Ministry of Natural Resources. Bancroft, Ontario.

From June 21st to September 7th, 1982 the staff of Silent Lake Provincially Park continued implementation of a voluntary creel census of Silent Lake at nominal cost.

A total of 15 lake trout were reported caught and an actual catch-per-unit-effort of 0.03 was calculated.

Forty-four percent of lake trout caught were of hatchery origin.

Grant, R. E. 1990. 1990 winter aerial creel survey of eastern Ontario inland lake trout and splake fisheries. Ontario Ministry of Natural Resources. Kemptville, Ontario. 35 p.

A winter aerial creel survey was conducted for the second consecutive year on 57 of the 81 designated lake trout and splake lakes in fishing Divisions 9, 10 and 29 during the open lake trout and splake seasons in February and March of

1990. In conjunction with the aerial survey, angler interviews were conducted on four splake lakes in Division 9, three splake lakes in Division 10 and ten splake lakes and 24 lake trout lakes in Division 29.

A total of 904 anglers were interviewed on 41 splake and lake trout lakes in Divisions 9, 10 and 29. Twelve anglers were interviewed on the four splake lakes in Division 9 during which time one splake was caught and harvested. Two hundred and seven anglers were interviewed on the three splake lakes in Division 10. A total of 30 splake were caught and 29 were harvested. In Division 29, 90 splake anglers were interviewed on ten lakes during which time 53 splake were caught and 45 were harvested. A total 595 lake trout anglers were interviewed on 24 lake trout lakes. An observed catch of 286 trout and harvest of 188 lake trout was recorded.

During the aerial survey 1,011 open ice anglers were observed on 17 designated splake lakes in Divisions 9 and 10 for February and March combined, while 63 open ice anglers were observed on 10 splake lakes in Division 29 during March. A total of 401 open ice anglers were observed on the 30 designated lake trout lakes surveyed in Division 29 during March.

Total estimated angling effort on the 17 splake lakes surveyed in Divisions 9 and 10 was approximately five times greater in February (11,185.2 angler hours [2.58hrs/ha]) than in March (2,198.7 angler hours [0.51 hrs/ha]). Total March angling effort on the ten surveyed splake lakes in Division 29 was 1588.5 angler hours (4.78 hrs/ha). Splake angling effort-per-unit-of-lake are in Division 29 during March (4.78 angler hours per hectare) was approximately 1.5 times greater than that in Divisions 9 and 10 for February and March combined (3.09 angler hours per hectare). Total splake angling effort estimates for Divisions 9, 10 and 29 increased only slightly in 1990 (14,972.4 angler hours) when compared with 1989 results (14,235 angler hours).

Total estimated angling effort on the 30 lake trout lakes in Division 29 during the March fishing season was 12,125.2 angler hours (1.56 hrs/ha). This reflects a 31% decrease in lake trout angling pressure when compared with the 1989 angling effort estimate of 17,542 angler hours (2.39 hrs/ha).

There was insufficient data collected for lakes in Division 9 to derive any catch, harvest and weight estimates. Total splake harvest estimates on lakes surveyed in Division 10 was 162 with an estimated weight of 193 kilograms or 0.12 kg/ha. In Division 29 the estimated splake harvest was 141 with an estimated weight of 55 kilograms or 0.17 kg/ha.

Estimated lakes trout harvest was 1,079 with an estimated weight of 113 kilograms or 0.02 kg/ha for the lakes sampled.

Overall, the estimated number of splake harvested from Division 10 and 29 splake lakes in 1990 (303 splake) equalled 28% of those harvested in 1989 from Divisions 10 and 29 (1,076 splake). The estimated number of lake trout harvested in Division 29 was also less in 1990 (1,079 lake trout) than in 1989 (1,737 lake trout).

In Division 10, the estimated harvest-per-unit-effort (number of fish per angler hour) of splake was slightly greater in 1989 (0.065) than in 1990 (0.052). In Division 29, the 1989 splake CUE and HUE estimates (CUE = 0.442; HUE = 0.374) were approximately four times greater than that in 1990 (CUE = 0.108; HUE = 0.089). The mean size of splake harvested in both 1989 and 1990 was significantly larger in Division 10 (0.515 kg, N = 25; 1.19 kg, N = 29, respectively) than Division 29 (0.283 kg, N = 253; 0.394 kg, N = 45, respectively).

Lake trout catch and harvest estimates (number of fish per angler hour) remained relatively constant for 1989 (CUE = 0.142; HUE = 0.133) and 1990 (CUE = 0.133; HUE = 0.089) in Division 29. Mean weight of sampled lake trout was slightly greater in 1989 (o.626 kg, N = 164) than in 1990 (0.563 kg, N = 177).

Fifty-one percent of the total observed harvest of lake trout in Division 29 possessed a fin clip indicative of hatchery origin.

Continuation of both the aerial and ground surveys for Division 9, 10 and 29 for the winter of 1991 is recommended.

Hall, B. 1969. A winter creel census on Fern Lake, Sault Ste. Marie District, 1969. Manuscript Report. Ontario Ministry of Natural Resources. Sault Ste. Marie, Ontario. 7 p.

During the winter months of January, February and March, 1969, anglers at Fern Lake caught an estimated 253 lake trout weighing a total of 149 pounds during 1,092 hours of fishing. The fishing intensity on this 204 acre lake was 5.35 man hours of effort-per -urface acre. The season average for the rate of success was 0.218 fish per man hour. The yield was 0.703 pounds per acre.

The lake trout introduced to Fern Lakes in 1964 produced in 1969 and estimated 3.5 pounds of fish for every pound planted. The cost benefit ratio was 1:3.54. The 1966 plant produced approximately ¾ of a pound of fish for every pound planted. The cost benefit ratio was 1:0.76.

The average total length and round weight of the lake trout from the 1964 plant was 15.7 inches and 1.0 pounds. The average total length and round weight of the lake trout from the 1966 plant was 10.3 inches and 0.2 pounds.

Stocking should be discontinued pending assessment of natural reproduction by a creel census or lake survey in the early 1970's.

Hansen, M. J., P. T. Schultz and B. A. Lasee. 1990. Changes in Wisconsin's Lake Michigan salmonid sport fishery, 1969-1985. North American Journal of Fisheries Management 10(4) : 442-457.

The modern sport fishery for salmonids in Wisconsin waters of Lake Michigan was begun during 1963-1969 with the stocking of rainbow trout (*Oncorhynchus mykiss*), lake trout (*Salvelinus namaycush*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), coho salmon (*O. kisutch*), and chinook salmon (*O. tshawytshca*). The fishery grew rapidly during 1969-1985 as angler effort increased 10-fold, catch rate doubled, and catch increased 20-fold. The stocking

and catch became increasingly dominated by chinook salmon, with coho salmon and lake trout of secondary importance, and brown, rainbow, and brook trout of least importance. Trolling dominated the fishery, particularly by launched-boat anglers. The catch by troller was dominated by chinook and coho salmon and lake trout. Pier, stream and shore anglers fished less overall, but had catch rates that were similar to launched-boat anglers. The catch by pier and shore anglers was spread among chinook and coho salmon and lake, brown and rainbow trout. The catch by stream anglers was dominated by chinook salmon. The percentage of stocked fish that were subsequently caught (catch ratio) was highest for fingerling chinook salmon (12.9%). Yearling brook trout, brown trout, coho salmon, lake trout, and rainbow trout had intermediate catch ratios (5.1-9.8%). Fingerling brook trout, brown trout, and lake trout had the lowest catch ratios (2.5-3.5%). The catch ratio for rainbow trout dropped from 9.8 to 5.1% after stocking with a different strain (the Shasta strain). Fingerling rainbow trout produced the lowest returns (<0.5%). We derived stocking recommendations for each species and life stage based on these catch ratios, and catch objectives based on maintaining catch levels recorded during 1983-1985.

Hansen, M. J., R. G. Schorfhaar, J. W. Peck and J. H. Selgeby and W. W. Taylor. 1995. Abundance indices for determining the status of lake trout restoration in Michigan waters of Lake Superior. North American Journal of Fisheries Management 15(4) : 830-837.

Self-sustaining populations of lake trout (*Salvelinus namaycush*) have returned to most areas in Lake Superior, but progress toward achieving historic commercial yields has been difficult to measure because of unrecorded losses to predation by sea lamprey (*Petromyzon marinus*) and to fisheries. Consequently, we developed restoration targets (catch-per-effort, CPE; geometric mean number per kilometre of 114-mm stretch-measure gill net during 1929–1943, when historic yields were sustained) from linear relationships between CPE in commercial and assessment fisheries in Michigan. Target CPEs for lake trout restoration were higher and less variable than the modern CPEs in all areas. Modern CPEs generally increased during the 1970s and early 1980s but declined during the late 1980s and early 1990s. Modern CPEs were highest in western Michigan from the Keweenaw Peninsula to Marquette (71 to 81% of target CPEs), but coefficients of variation (CV, SD/mean) of mean CPEs were 1.4 to 2.4 times greater than target CVs. Around Munising, the modern CPE was lower (41% of the target CPE), whereas the CV was 1.9 times greater than the target CV. Around Grand Marais, the modern CPE was lowest among all areas (17% of the target CPE), but the CV was nearly the same (1.1 times the target CV). In Whitefish Bay, the modern CPE was only 28% of the target CPE and the CV was 9.0 times greater, though the modern period was based on only the years 1979–1982 and 1984–1985. Further progress in restoration in most areas can be achieved only if fishery managers adequately protect existing stocks of wild fish from sea lamprey predation and fishery exploitation.

Healey, M. G. 1978. The dynamics of exploited lake trout populations and implications for management. Journal of Wildlife Management 42 : 307-328.

This report examines mortality, growth, reproduction, and potential yield of lake trout (*Salvelinus namaycush*) with a view to understanding the dynamics of

exploited trout populations. Natural mortality rates were low (10-37%) except in the presence of lamprey. Total mortality rate of exploited populations ranged up to 92 percent, but populations with mortality in excess of 50 percent were declining. Growth in length varied twofold between populations and exploitation appeared to elicit more rapid growth. Size at first maturity ranged from 330 mm to more than 600 mm and age of first maturity 5 years to 19 years. Age and size at maturity were not correlated. Five years was the minimum age of maturity even in populations declining due to high mortality. Intermittent spawning occurred and was more common in northern populations. Fecundity ranged from 840 eggs/kg to 1,700 eggs/kg, and the relationship between length and fecundity varied between populations and between years within but not necessarily in relation to exploitation. Population size averaged 6/ha for most populations. Most production was confined to the youngest age classes and production and biomass of mature trout was very low. Estimated yields were less than 0.5 kg/ha for all populations. Although mortality, growth, and maturity may be used as indicators of fishery potential and fishery development they are not certain indicators in trout populations. Available data indicate, however, that exploitation should not exceed 0.5 kg/ha and mortality should not be increased beyond 50 percent.

Hickory, R. 1973. Dwindling Ontario lake trout populations. Ontario Fisherman and Hunter 5(11) : 17.

Hicks, F.J. 1985. Creel Surveys, 1976-1982. Algonquin Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Whitney, Ontario.

Lake trout is the major sport fish of Bark Lake. Angling success was slightly lower in 1980 than the catch-per-unit-effort (CPUE) values recorded in 1979 and similar to values reported in 1966, 1970 and 1973.

The mean long term CPUE for lake trout is 0.092 fish/rod hour. The C.V. for the observed CPUE was 0.41 for lake trout which exceeds the threshold limit set out for lake trout in SPOF #15.

The mean fork length, mean age and mean age of lake trout in the creel are very consistent and except for mean weight, show little variation and are similar to data from naturally reproducing lake trout populations in other lakes in the Algonquin Fisheries Assessment Unit.

In addition to exploitation, Bark Lake has been stocked regularly since 1966 to compensate for loss of natural reproduction from an annual drawdown of 10m by Ontario Hydro. Marked lake trout represented 27% of the catch during 1980. In the past the percentage of marked fish in the creel has ranged from 39.2% to 64.8%.

The anglers of Bark Lake were almost exclusively residents of Ontario with few non-residents encountered during the creel survey.

Hicks, F. J. 1986. The Opeongo creel survey, 1985-86. Manuscript Report. Algonquin Fisheries Assessment Unit. Ontario Ministry of Natural Resources.

Hile, R. 1948. Trends in the lake trout fishery of Lake Huron through 1946. Transactions of the American Fisheries Society 76 : 121-147.

The tremendous decreases in production that have occurred in all parts of Lake Huron in recent years are generally believed to have been caused by a reduction in the abundance of the lake trout resulting from attacks by the sea lamprey, which has become established and has multiplied rapidly in the upper Great Lakes.

On the whole, the abundance of lake trout appeared to have little effect on the fishing intensity for the species. Only in H-1 did the two exhibit significant positive correlation whereas in H-6 they showed highly significant negative correlation. Most of the factors that may counteract the expected influence of abundance on fishing intensity (economic conditions, weather, etc.) cannot be evaluated accurately. It was determined, however, that the collapse of the whitefish fishery in the middle and late 1930's most probably exerted a significant depressing effect on the intensity of the gill-net fishery for lake trout in those districts (H-1, H-4, H-6) in which the two species are ordinarily captured together.

The estimated abundance of lake trout in the United States waters of Lake Huron (all districts combined) had reached an extremely low level in 1946 (24 percent of the 1929-1943 average), and the complete collapse of the fishery in later years is a matter of record. The rate of decline in abundance, however, was much less rapid than the spectacular decreases in production might suggest. Although each year beginning with 1940 saw a new record low, the abundance was still 87 percent of average in 1942 and did not drop below 70 percent until 1944. This seeming paradox is explained by the fact that relative to average conditions, fishing intensity in 1941 to 1946 was lower and was decreasing much more rapidly than was abundance.

Hile, R., P. H. Eschmeyer, and G. F. Lunger. 1950. Status of the lake trout fishery in Lake Superior. Transactions of the American Fisheries Society 80 : 278-312.

The production of lake trout in the United States waters of Lake Superior was low (only 1,465,000 pounds) in 1879, the first year for which there is a record. Expansion of the fishery must have started soon thereafter for the take was 3,488,000 pounds in 1885, the next year for which we have statistics, and averaged 3,416,000 pounds from 1885-1892. The years after 1892 can be divided readily into three general periods with average yields as follows: 1893 to1907 - 4,599,000 pounds; 1908 to 1925 - 2,168,000 pounds; 1926 to 1949 – 3,049,000 pounds. A take of 3 million pounds can be held as "normal" in the modern fishery. During the three periods just listed the percentage contributions of the individual states to the United States total (as computed from the averages from individual periods) ranged from 65.1 to 71.5 for Michigan, 17.5 to 25.6 for Wisconsin, and from 9.3 to 11.0 for Minnesota.

In the Canadian (province of Ontario) waters of Lake Superior the average annual output of lake trout rose from 309,000 pounds in 1871-1882 to 900,000 pounds in 1883-1893, 1,567,000 pounds in 1894-1903, and 2,189,000 pounds in

1904-1918. This last period of relatively high yield was followed by two intervals of successively lower average catches – 1,691,000 pounds in 1919-1929 and 1,395,000 pounds in 1930-1949.

The short-term fluctuations of production during the more recent years give evidence of periodicity in the output of lake trout in Michigan, Ontario, and in the entire lake. Furthermore, these periodic fluctuations tended to be similar in Michigan and Ontario waters. The co-efficient of correlation (*r*) between production in Michigan and Ontario in 1920-1949 (after elimination of trend in the statistics for both areas) had the significant value of 0.456. This correlation suggests that Michigan and Ontario fishermen exploit a common stock or stocks subject to similar fluctuations.

The condition of the lake trout fishery of the State of Michigan waters of Lake Superior must be termed unhealthy and the outlook for the future is not good. Production in 1949 stood at 106 percent of the 1929 to 1943 mean, but this level of yield was made possible only by fishing intensity that was 162 percent of average; the abundance index in 1949 was only 65. Certainly, stocks of lake trout are in a poor state to withstand the threatened inroads of sea lampreys which have been taken from all parts of Lake Superior and are known to have established spawning runs at least as far west as the Keweenaw Peninsula.

Hile, R., P. H. Eschmeyer, and G. F. Lunger. 1951. Decline of the lake trout fishery in Lake Michigan. United States Fish and Wildlife Service. Fisheries Bulletin 52 : 77-95

Himburg, G. F. 1971. Winter creel census, Perry Lake 1971. Manuscript Report. Ontario Ministry of Natural Resources. Cochrane, Ontario.

A winter creel census conducted on Perry Lake during the winter of 1971 showed that 114 anglers harvested 91 lake trout during the census days giving a catch-per-unit-effort of 0.117. Age class IV comprised 57% of the total harvest. All the specimens in age class IV were identified, by fin clip, as stocked lake trout from the 1970 stocking of three year old fish. The fishing intensity on the lake was 2.9 man hours-per-surface acre.

Howland, K. L., R. F. Tallman and K. Mills. 2002. Implications of life history variation for management of lake trout in Great Bear Lake, Northwest Territories. International Association for Great Lakes Research Conference Program and Abstracts 45 : 57.

Great Bear Lake represents one of the only remaining large lake trout populations in North America, thus providing a unique opportunity to study natural variability of this species in a large lake system. Great Bear lake supports a trophy lake trout fishery as well as a small subsistence fishery in Keith Arm (near the community of Deline). It is currently managed by geographic area under the premise that trout exhibit minimal movement between different arms of the lake. As part of our research, we have been collecting baseline biological data on lake trout in the Keith Arm to determine productivity of the stock and safe harvest levels. Lake trout in the Keith Arm exhibit considerable life history variation and may be comprised of more than one form, a situation that has also

been observed in other large lakes. This variation has been extinguished in these more southerly populations due to overexploitation. We discuss the implications of our findings to future research and management of lake trout in Great Bear Lake. Recently proposed community initiatives are expected to increase tourism and associated sport fishing activity. Given our results and the example of other large lakes we believe it is important to direct research towards understanding the underlying source of life history variation in lake trout stocks.

Hoyle, J. A. and N. G. MacLean. 1988. Exploitation assessment of five southeastern lake trout fisheries supplemented by stocking. Rideau Lakes Fisheries Assessment Unit Report No. 17. Ontario Ministry of Natural Resources. Sharbot Lake, Ontario. 46 p.

The Rideau Lakes Fisheries Assessment Unit has collected trend-through-time data since 1981 for five lakes supporting lake trout populations. Though natural reproduction in these lakes remains significant, native lake trout populations are supplemented annually by stocking yearling lake trout. In this report, we focus on data (angling effort and lake trout yield, abundance, mean age in the anglers harvest, mortality, and growth) collected during creel surveys conducted annually and biennially for winter and summer lake trout seasons respectively from 1981 to 1986. We compare winter and summer lake trout fisheries, contrast the performance of native and stocked lake trout, and assess the level of exploitation on these lake trout populations.

Hoyle, J. A. and T. J. Stewart. 1987. Lake trout exploitation stress assessment on Drag, Dickey, and Twelve Mile lakes. Haliburton-Hasting Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Bancroft, Ontario. 50 p.

Exploitation stress was assessed for the native lake trout populations of Drag, Dickey, and Twelve Mile lakes. Winter, spring and summer creel surveys and fall trap and gillnet studies were carried out from 1981 to 1985. Drag Lake, where angling effort was moderate (5.8 angler hours/ha/yr), CUE was high (0.266), and annual yield was not excessive (0.33 kg/ha, RORY = 66%), was not overexploited during the study period. Though mortality rates were moderate to high, spawning escapement was sufficient to allow increased recruitment to this fishery over the study period. Dickey Lake was clearly overexploited during the study period. Annual effort (21.6 angler hours/ha/yr), yield (0.82 kg/ha, RORY = 113%), mortality (0.79), and variation in abundance and year class strength were high, and CUE (0.099) and mean age at maturity (4.6 years) were low, all indicating a stressed population. Twelve Mile Lake may not have been overexploited during the study period. Annual effort (9.1angler hours/ha/yr), yield (0.46 kg/ha, RORY = 78%), and mortality (0.49) were all considered moderate to high. However, very low angler CUE (0.060), high variation in abundance and year class strength, and poor spawning escapement suggest that Twelve Mile Lake was overexploited in the past. We recommend that steps should be taken to reduce lake trout exploitation on Dickey and Twelve Mile Lakes.

Houston, K. A. and J. R. M. Kelso. 1990. Lake trout (*Salvelinus namaycush*) mortality: A review. Great Lakes Fishery Commission Research Completion Report. Canadian Department of Fisheries and Oceans. Sault Ste. Marie, Ontario. 24 p.

Lake trout (*Salvelinus namaycush*) mortality estimates were summarized for a number of populations in an attempt to understand the dynamics of lake trout populations, and the influence of exploitation and sea lamprey predation. Estimates of mortality were extremely variable; however, it appears that natural mortality (from sources other than fishing or sea lamprey predation) is in the range of M = 0.10-0.25 for all populations examined. Fishing mortality is regulated by the management agencies and, therefore, was site specific. Lamprey induced mortality was more difficult to quantify with estimates ranging from L = 0.21-1.70 (mean = 0.721 ± 0.454; N = 12). It is apparent that lamprey contribute to the mortality of lake trout, however, magnitude of that contribution is still uncertain.

Hudgins, M. D. and W. D. Davis. 1984. Probability angling: A recreational fishery management strategy. North American Journal of Fisheries Management 4 : 431-439.

Probability angling is a "recreational" fishery management strategy that uses catch assessment data to establish criteria for evaluating personal "recreational" angling success. Angling groups on two reservoirs on each of two river drainages in the southwestern United States were asked to rate their incompleted trip quality and fishing-success as either poor, fair, good or excellent. Trip quality ratings were not correlated with ratings of fishing-success. Total weight and total number of fish caught per incompleted trip were correlated best with fishing-success ratings among eight descriptors of each group's catch. Drainage catches (via pooling catches from two reservoirs) were significantly different regarding total number of fish per angling group, yet anglers did not rate their fishing success differently between drainages. Collectively, fishermen adjusted their success expectations (i.e., mean number of fish caught within each success category) according to intended target and river system fished. Virtually identical ranges of numbers of fish-per-angling group within each success category demonstrated that individual fishing-success ratings were subjective. Ranges of numbers of fish below a creel limit (based on descending percentile probabilities of catching fish) were classified as poor, good, and excellent to operationally define probability angling success. Developing and posting this information for each fishery would provide managers and anglers with resource specific descriptions of quality fishing.

Hughson, D. R. 1965. Report on Panache (Panage) Lake winter angling success 1965. Manuscript Report. Ontario Department of Lands and Forests., Sudbury, Ontario. 4 p.

During the winter of 1965, 487 anglers fishing 2,136 hours took 154 lake trout, 4 walleye, 1 whitefish, and 2 ling. These figures would represent approximately 30% of the total catch and effort for the winter of 1965. Comparing the data for 1965 with 1960-61, an improved catch-per-unit-effort is noticed. In 1960-1.6; 1961-3.1; 1965-7.2 trout per 100 rod-hours. However, 60% of the lake trout

caught in 1965 were under 14 inches and under. The average length of trout caught declined from the 1961 figure of 18.6 to 15.2 in 1965. The lake trout to walleye ratio varied from approximately 2:1 in 1960 and 1961 to 38:1 in 1965. The same locations and methods were used in the winters, with the exception of the use of 2 lines per angler in 1965.

It appears possible at the present time, that the Penage Lake, lake trout fishery has been substantially improved by the introduction of the hatchery stock. It is our opinion, in view of the criticism we have received from Lake Penage tourist outfitters and camp owners, that future management of the fishery will have to follow one of two courses or a combination of both. We have already received a petition to close the lake to winter fishing. Close is one method suggested to maintain the quality of angling. The creel census data suggests that since the 1962 and 1963 introductions, the quality of fishing has improved. If this is correct, the introduction of hatchery stock is the method recommended. Ten to twenty thousand yearlings would be an estimate of the number of trout required. However, information on some fin-clipped plantings would assist greatly in the establishment of our stocking requirements.

Hughson, D. R. 1966. Report on Panache (Panage) Lake winter angling success 1966. Manuscript Report. Ontario Department of Lands and Forests. Sudbury, Ontario. 4 p.

During the winter of 1966, 712 anglers fishing for 3,315 hours caught 319 lake trout, 4 walleye, 4 whitefish, 19 ling. This would represent approximately 30% of the total catch and effort for this winter of 1966. Small trout make up the majority of the angler's catch and contribute to the improved catch-per-unit-effort of 9.1 trout per 100 rod hours compared to 7.2 in 1965. The ratio of walleye to lake trout remains low at 1 to 79.7, compared to 1 to 38 in 1965 and 1 to 2 in 1960 and 1961. The same method and locations are being used.

Undoubtedly heavier angling pressure would have been exerted had it not been for extremely dangerous ice conditions. An improved catch-per-unit-effort lake trout is again evident, and small trout continue to make up the major portion of the angler's catch. The 1966 planting of marked lake trout will assist in establishing the origin of the immature trout caught by the winter angler. Future management plans for Penage Lake will depend on the results obtained in the identification of origin of immature trout.

Irwin, K. 1983. A summary of a 100% winter creel census on three oligotrophic lakes in Bancroft District, 1983. Bancroft District Fisheries Management Report 1983-01. Ontario Ministry of Natural Resources. Bancroft, Ontario.

Irwin, K., J. Brisbane and D. Gillap. 1985. A summary of an intensive open water creel census on four Bancroft District lakes, 1983. Bancroft District Fisheries Management Report 1985-01. Ontario Ministry of Natural Resources. Bancroft, Ontario.

Three lake trout/bass lakes, Anstruther, Eels and Chandos were censused during the summer and fall.

Results indicate that lake trout anglers experienced the best success on Anstruther Lake while Eels and Chandos provided fair and poor quality lake trout angling respectively. Although the 3 lakes are stocked with lake trout, domestic trout contributed only to the anglers catch from Eels Lake.

The summer and fall harvest exceed the estimated annual allowable yield for lake trout on Anstruther and Eels Lakes. The lake trout populations in these lakes may be overexploited. The summer and fall lake trout harvest from Chandos Lake was well below the allowable yield.

During the summer and fall season most fishing pressure on the lakes creeled comes from cottagers. On Anstruther, Eels and Chandos lakes these anglers are almost exclusively Ontario residents.

Irwin, K. and J. Brisbane. 1985. A summary of a 100% spring and summer creel census on Silent Lake, 1985. Bancroft District Fisheries Management Report 1988-05. Ontario Ministry of Natural Resources. Bancroft, Ontario.

A 100% spring and summer creel census program was conducted in Silent Lake from May 14th to September 2nd, 1985.

The 2632 anglers interviewed during the creel program exerted an angling effort of 5242 hours (38.12 hr/ha).

Bass were the target species of 58% of the anglers and 17.6% were seeking lake trout. The results of the creel census indicated that the estimated annual allowable yield for lake trout was exceeded suggesting that lake trout may be overharvested.

Biological data were collected from 69 lake trout, 91 largemouth bass and 82 smallmouth bass. The lake trout data indicated that 88% of the harvested fish were immature. Hatchery fish contributed very little to the spring/summer angler success. The largemouth and smallmouth bass data showed strong representation from the 4 and 6 year age groups.

The majority of the resource users were from Ontario and were camping at Silent Lake Provincial Park. Forty-nine percent of the anglers who responded to a visitor survey indicated they would visit the park more often and fish more if the fishing were to improve.

Irwin, K. 1989. A summary of intensive open water creel surveys, Bancroft District 1986-1987. Bancroft District Fisheries Management Report 1989-01. Ontario Ministry of Natural Resources. Bancroft, Ontario.

Johnson, L. 1976. Ecology of Arctic populations of lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), arctic charr (*S. alpinus*), and associated species in unexploited lakes of the Canadian Northwest Territories. Journal of the Fisheries Research Board of Canada 33 : 2459-2488.

The available data on the fish populations of 35 lakes in the Northwest Territories are examined. The lakes range in size from Great Bear Lake (31,156 km^2) to Key Hole Lake (46 ha); they are situated between 60° and 75° N, east from the Mackenzie River to the west coast of Hudson Bay. Lake trout (*Salvelinus namaycush*) and lake whitefish (*Coregonus clupeaformis*) form the main populations of the mainland lakes and together make up to 90% of the total catch. There is a trend toward increasing importance of the whitefish with decreasing severity of conditions. Most populations show a uni-, bi- or trimodal length distribution; age distributions are unimodal. No change in these distributions was observed over a large number of years in certain lakes. These populations are considered to have reached a climax condition comparable with a vegetational climax, and are therefore in equilibrium with their environment. All incoming energy is ultimately used in respiration to support a high biomass of fish.

Jorgensen, C. R. 1973. A summary of the five year study of the Lake Temagami lake trout fishery. Nipissing-Temagami Fisheries Management Unit. Ontario Ministry of Natural Resources. 190 p.

Data is presented for the 1971 fishing season on Lake Temagami. Catch-effort statistics were summarized for the six year period 1966-1971. The lake trout fishery was described from 1958 to 1971. Growth rates, age class composition, age for sexual maturity, length-weight relationship and total mortality rates were presented. The contribution of the annual lake trout stocking program was also determined for plantings from 1961 to 1971.

Creel census results from 1966 to 1971 showed that overexploitation of the lake trout took place in 1966, 1967 and 1968. There was no data to estimate the annual harvests for 1969 and 1970. In 1971, the trout harvest decreased mainly because three fishing camps closed down.

From 1958 to 1971, lake trout fishing pressure increased year after year except for the summer of 1971. While the fishing pressure was increasing, the size and weight of the angler caught trout was decreasing. In winter, the average weight dropped from 3.04 lbs in 1958 to 1.74 lbs in 1971. In summer, it dropped from 3.8 lbs in 1967 to 2.9 lbs in 1971. Also, more sexually immature trout were caught each year. In 1961, the number of sexually immature trout taken was insignificant while 83.7% of the 1971 winter harvest and 56.2% of the summer harvest were immature.

Lake trout stocking with yearlings has shown an insignificant contribution to the fishery. Since 1961, 132,500 fin clipped yearlings have been stocked in the lake. 3,312 trout have been examined for clipped fins and only 17 were found.

The increased harvest of whitefish may be the result of decreased predation resulting from a decrease in older lake trout.

If the increase in rate of exploitation is not stopped it will mean the eventual demise of the lake trout.

Keleher, J. J. 1972. Great Slave Lake: Effects of overexploitation on the salmonid community. Journal of the Fisheries Research Board of Canada 29 : 741-753.

A 20-year investigation commenced at the inception of the Great Slave Lake commercial fishery, and it is inferred that exploitation has been the sole cause of change in the fish stocks. Background information on the operation of the commercial fishery, fishing regulations, and the study methods are provided. Lake whitefish (*Coregonus clupeaformis*) and lake trout (*Salvelinus namaycush*) have made up 94% of the commercial fish landings of 119 million lbs during the period. Only three other species of the 25 occurring in the lake were usually marketed. Whitefish catches generally were distributed equally between the summer and winter seasons. Trout were caught almost exclusively during the summer season. The annual catch of these two species rose from 1.6 million lbs in 1945 to a maximum of 9.4 million lbs in 1949 then gradually decreased to about the 5 million lb level. The study data have been partitioned according to 13 statistical areas. Catch has not been in proportion to the extent of these areas. Whitefish catch has predominated in the western, interior lowlands, portion of the lake, while trout catch has predominated in the eastern Canadian Shield portion. In various areas, the peak catches for whitefish were associated with peak catches for trout, indicating that both were the result of fishing down the virgin stocks. Summer catch-per-unit-effort (CPE) for each species has declined during the 20-year period. CPE varied with statistical areas. The usual observed reduction for whitefish was 60% in contrast to 93% for trout. Estimated summer fishing effort and whitefish catch showed a direct relation but for the trout usually changed from a positive to a negative one. The average size of commercially caught fish has declined to about 2 lbs for whitefish and 5 lbs for trout. Information on catch-per-unit-effort for other species indicates no evident explosions in their numbers, though ciscoes (*Leucichthys* spp.) have increased in abundance. Although the fishery was regulated in order to provide for maximum sustainable yields, this has not been achieved for trout. Three options for this are offered. Exploitation under a pooled quota system for whitefish and trout is not favoured and a decrease in trout quota is recommended.

Kerr, S. J. 1985. Gillies Lake volunteer creel census program, winter 1985. Manuscript Report. Ontario Ministry of Natural Resources. Owen Sound, Ontario. 8 p.

For the second consecutive year, a volunteer creel census program was carried out during the winter fishing season on Gillies Lake.

Ice hut fishermen reported exerting 305.0 man hours (683.5 line hours) of angling effort to catch a total of 135 fish.

Lake trout comprised 86.7% of the reported catch. Anglers reported releasing 27% of the lake trout caught.

The mean size of lake trout, which were caught and kept, was 13.5 inches (34.3 cm).

Fin clipped fish accounted for 64.3% of the lake trout harvest.

It is recommended that a similar program be initiated during the winter of 1986.

Kerr, S. J. 1991. Results of an aerial survey of the 1991 open water lake trout and splake fisheries in Divisions 9, 10 and 29. Ontario Ministry of Natural Resources. Kemptville, Ontario. 18 p.

An aerial creel survey was carried out from May 19 to September 18, 1991 to assess angling activity on inland lake trout and splake fisheries. A total of 6,017 anglers were recorded during the survey.

An estimated 30,723 angler hours of fishing effort was exerted on twenty-six splake fisheries in Divisions 9, 10 and 29.

An estimated total of 391,913 angler hours of effort was expended on forty-seven inland lake trout lakes during the survey period. Lake trout angling activity was particularly heavy on lakes in Divisions 9 and 10.

Based on estimates from both winter and open water aerial creel surveys in 1991, annual fishing pressure estimates were calculated for individual lakes. Despite a series of new regulation changes designed to reduce fishing pressure on local lake trout stocks, angling pressure on 32 lakes (68%) exceeded to optimal level of angling activity.

Recommendations are:

- Verify spring and summer lake trout angling effort.
- Conduct more angler interviews and fish sampling.
- Intensify F_1 splake stocking assessment.
- Add Carleton Place District lakes to aerial survey.
- Refine parameters used to estimate fishing pressure.

Kerr, S. J. 1991. Results of a 1991 winter survey of lake trout and splake fisheries, eastern region. Ontario Ministry of Natural Resources. Kemptville, Ontario. 22 p.

For the third consecutive year an aerial creel survey, supplemented by on-the-ground angler interviews was conducted on splake fisheries in Divisions 9 and 10 as well as lake trout and splake fisheries in Division 29. The 1991 survey involved a total of 29 flights comprising 68.6 hours of flying time. During the survey 3,668 open-ice anglers were recorded on 56 designated lakes. The majority of these anglers were recorded on weekend days.

Estimated winter fishing pressure for F_1 splake ranged from 5,057.3 angler hours in Division 29 to 17,822.9 angler hours in Division 9. An estimated total of 28,704.9 angler hours of effort (7.3 angler hours/ha) was directed to eastern Ontario splake fisheries which were included in this survey.

During a three week season in March (March 9-31), an estimated 33,914.6 angler hours of fishing effort (4.37 angler hours/ha) were expended on thirty lake

trout lakes in Division 29. Winter fishing pressure reached as high as 38.8 angler hours/ha on Crystal Lake.

Overall, it was estimated that 1,464 F_1 splake and 3,222 lake trout were harvested from fifty-six selected lakes in these three divisions during the 1991 winter fishery. Winter lake trout yields, for those lakes on which calculations were possible, suggest that many waters exceed recommended annual harvests and are probably being overexploited.

As noted in earlier surveys, the overall lake trout catch was split almost evenly between native and stocked (hatchery-reared) fish.

A review of historic creel data is presented which suggests that earlier amendments to the winter fishing regulations have not resulted in a decrease in lake trout angling activity in Division 29. Several recommendations for future management initiatives and regulation amendments are offered for consideration.

Recommendations:

1. Initiate an open water creel survey.
2. Intensify F_1 splake sampling efforts.
3. Expand winter open seasons for F_1 splake.
4. Seek/evaluate larger F_1 splake hatchery product.

Kerr, S. J. 1992. Results of an aerial creel survey of lake trout and splake fisheries in Divisions 9, 10 and 29, winter 1992. Ontario Ministry of Natural Resources. Kemptville, Ontario. 21 p.

An aerial survey was carried out on sixty inland lake trout and F_1 splake lakes in Divisions 9, 10 and 29 during the open season in February and March of 1992.

During 41 flights, a total of 6,355 open ice anglers were recorded. In conjunction with the aerial survey, 637 lake trout anglers and 892 splake anglers were randomly contacted and interviewed. Two hundred and six (206) angled lake trout and 523 splake were weighed and/or measured as well as being examined for fin clips.

Estimated winter angling pressure for splake was 23,221.3 angler hours in Division 9; 6,252.6 angler hours in Division 10; and 5,320.5 angler hours in Division 29. An estimated 21,804 splake were harvested from these three areas in the winter of 1992. Splake catches and angling success rates were the highest recorded in all three divisions since the winter survey commenced in 1989.

Winter lake trout angling pressure remained high in Division 29. March angling effort directed at lake trout was estimated at 28,195.9 angler hours. This value probably represents an underestimate since winter angling activity continued well into the month of April. The estimated harvest was 2,594 fish. Lake trout catch rates (catch-per-unit-of-effort) have remained relatively constant during the past four years however the proportion of hatchery reared fish in the catch has increased annually since 1990.

Recommendations:

1. Maintain an annual assessment of winter lake trout and splake fisheries.
2. Conduct more detailed investigations on underproducing splake fisheries.
3. Continue to stock large yearling F_1 splake.

Kilby, M. 1982. Winter creel census on Galeairy, Gliskning, Lobster and McCauley Lakes. Ontario Ministry of Natural Resources. Whitney, Ontario.

In general, fishing effort was very low as well as the catch and the catch-per-unit-effort (CUE) for all lakes sampled during the period.

Of the 5 lake trout sampled, only two had left ventral and adipose clips. There were lake trout of the Smoke Lake strain, and both came from McCauley Lake. Too few fish were encountered in the survey to adequately assess the relative success of the two strains of lake trout. The obtaining of data through winter creel census on these study lakes may be difficult and time consuming, viable alternates may be either to trap net or gill net these lakes to obtain a suitable sample size.

Lamarre, T. and H. Reid. 1979. Aerial creel census report, March to June 1979. Manuscript Report. Ontario Ministry of Natural Resources. Napanee, Ontario. 16 p.

An aerial creel program was conducted on 24 lakes in the Napanee and Brockville Administrative Districts from March 10 to June 30, 1979. Only the data on the 13 lakes within the Napanee District are presented in this report.

For all but one lake (Loughborough) significantly higher fishing pressure estimates were obtained for the 18-day ice fishing season (March) than for any other month.

In calculating the data for March, it became apparent that factors including ice conditions and behaviour of ice fishermen must be taken into account during sampling in order to avoid biased fishing pressure estimates.

In every lake except Loughborough, fishing pressure was significantly higher during the March, ice fishing season than during any other month. In the case of Loughborough Lake, the lake trout population has been severely decimated since the accidental introduction of smelt and no longer supports a viable lake trout sport fishery.

Lawrie, A. H. and J. F. Rahrer. 1972. Lake Superior: Effects of exploitation and introductions on the salmonid community. Journal of the Fisheries' Research Board of Canada 29 : 765-776.

Lake Superior is highly oligotrophic and not very productive. It has not, however, been much affected by man's activities. Substantial quantities of woody allochthonous materials entered the lower reaches of tributaries and their estuaries from the pioneer lumbering industry. These undoubtedly depreciated

the shallow-water benthic environment and may have adversely affected fish stocks in the immediate areas concerned, especially those of lake sturgeon (*Acipenser fulvescens*) and lake whitefish (*Coregonus clupeaformis*). At present, local areas of urban or industrial pollution can be identified but, in general, appear to have had little adverse effect on fish stocks, although the collapse of one walleye stock has been attributed to pollution from a paper mill. Every commercial species has, however, been severely depleted. Recent declines can be correlated with predation by sea lamprey (*Petromyzon marinus*) but, without exception, all species give evidence of extensive over-fishing long before sea lamprey entered the lake. That this has not been more obvious is due to the stratification of catch statistics by arbitrary geographical areas (statistical districts) which are too large to relate meaningfully to either fish distribution or patterns of fishery operations. Because fish are generally distributed as local, often small, quasi-discrete stocks, they were exploited sequentially by the young, developing fishery. In this way stock after stock was depleted while conventional yield statistics gave the impression of relative stability. The lag before these statistics indicated the decline appears to have related to the degree of dispersal characteristic to each species. Thus the decline of the sturgeon was first evident, that of the lake trout (*Salvelinus namaycush*) last. Recovery has been slight but modern hatchery technology clearly provided a prospect for rejuvenating existing stocks or developing new ones. In either case, such synthetic populations will offer favourable opportunities for detailed investigation of the nature of fish distribution and its bearing on the interpretation of catch statistics.

Lockwood, R. N., J. Peck and J. Oelfke. 2001. Survey of angling in Lake Superior waters at Isle Royale National Park, 1998. North American Journal of Fisheries Management 21(3) : 471-481.

An on-site, direct-contact creel survey was conducted in the Lake Superior waters of Isle Royale National Park during June-August 1998 to estimate fishing effort, sport catch, sport harvest, and residency of non-charter boaters. The sport harvest of lake trout (*Salvelinus namaycush*) and coaster brook trout (*S. fontinalis*) was of particular concern. Estimates were based on boat counts from air flights and from the ferry vessel Voyageur II, as well as from interviews of boating parties at Isle Royale, Michigan, ports; at Grand Portage, Minnesota; and onboard the ferry vessel Ranger III. Total boating effort at Isle Royale National Park during June-August was 29,273 hours, of which 696 hours (2%) involved charter fishing boats, 19,340 hours (66%) non-charter fishing boats, and the remaining 9,237 hours (32%) nonfishing boats. Most boaters were from Minnesota and Michigan, which together accounted for 95% of the non-charter anglers and 70% of the nonfishing boaters. Total angler hours for the period were 62,232. Lake trout numerically were more than 90% of the sport catch; the harvest was estimated at 9,612 fish, with an additional 10,760 fish caught and released. Eight other species were reported in the catch, but variance associated with the much lower estimates precluded a comparison of harvest among these species. No coaster brook trout were reported in the catch. The fishing effort and harvest estimated in our survey was judged to be too low to harm any fish stock in Isle Royale National Park, but future creel surveys similar to this one are recommended.

Loftus, D. 1982. Winter creel census, 1981: Dickey, Drag, Koshlong and Twelvemile Lakes. Manuscript Report. Haliburton-Hastings Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Bancroft, Ontario. 23 p.

Winter angling fisheries for lake trout occur on four Haliburton-Hastings Fisheries Assessment Unit lakes – Dickey, Drag, Koshlong and Twelvemile.

Creel censuses were conducted on these lakes during the winter of 1981 to measure angling effort and success, and to characterize target populations. The project provided an opportunity to prepare a creel census design and test its effectiveness.

Dickey Lake (214 ha) is a lake trout – bass lake, with an MEI value of 4.9. Lake trout have been stocked since the 1920s. Resident lake trout are small and planktivorous. There is extensive cottage development along the shoreline. Both cottagers and local residents fish the lake during the winter months. Fishing huts are not used and most anglers remain quite close to shore over water 3 to 6 metres in depth.

The average fishing effort on weekend days was 32 angler hours, or about twice that observed on weekdays. However, weekdays and weekend days contributed almost equally to the overall fishing effort for the sampling period.

Fishing success was reasonably good. The catch-per-unit-effort (CUE) for lake trout was 0.15 fish per hour, but some of the smaller fish were released so that the effective CUE was 0.135 fish per hour.

Drag Lake (1008 ha) is a lake trout – whitefish – bass lake. It has been stocked with lake trout since the 1920s. Some quite large trout have been taken from the lake. There were about 15 fishing huts on the lake during the winter of 1981 and, in contrast to Dickey Lake, many anglers used snowmobiles.

Fishing success was good (CUE = 0.24 trout-per-hour) but the fish caught tended to be quite small and about 37% of them were released, bringing the effective CUE to 0.165 trout per angler hour.

The harvest was estimated to be 600 ± 188 trout weighing 168 ± 92 kg. This is equivalent to 0.15 ± 0.08 $kg \cdot ha^{-1}$. The average harvest during the winters of 1976 and 1977 was 0.16 $kg \cdot ha^{-1}$.

Koshlong Lake (401 ha) is a lake trout – smallmouth bass lake with an MEI value of 2.88. Lake trout have been stocked in the lake since the 1950s. Rainbow smelt are well established in the lake and provide a forage base for the trout, which are relatively fast growing.

Average weekday fishing effort (45 angler hours) was 3 times greater that weekday effort. Total fishing effort during the sampling period was 2,173 ± 1,310 angler hours, or 5.4 ± 3.3 angler hours per ha^{-1}. Local residents contributed about 30% of the total fishing effort and accounted for about 25% of the harvest. Cottagers and other Ontario residents made up the balance.

Lake trout fishing success (0.148 fish per angler hour) was comparable to that observed on Dickey and Drag Lakes. The trout caught tended to be somewhat larger, however, and very few were released. The effective CUE was 0.145 fish per angler hour.

The winter harvest of trout was estimated to be 322 ± 194 fish weighing 315 ± 190 kg. This is equivalent to a yield of 0.54 kg per hectare.

Twelvemile Lake (476 ha) is a lake trout – whitefish – bass lake. Lake trout have been stocked in the lake for many years. Rainbow smelt are well-established.

There were about 15 fishing huts on Twelvemile Lake during the winter of 1981, and 3 of these were on the Little Boshkung portion of the lake.

Average weekend day fishing effort (60 angler hours) was about 4 times greater that average weekday effort. Total fishing effort for the period of January 1-March 31 was estimated to be 2573 ± 1146 angler hours or 5.4 ± 2.4 angler hours-per-hectare. This estimate does not take into account the small amount of night-time fishing that was done by parties who slept in the huts, but we feel the estimate is reasonably accurate nonetheless.

Twelvemile Lake anglers were less successful that those on the other lakes. Average CUE values were 0.047 fish/hr for lake trout and 0.004 fish/hr for whitefish. The lake trout tended to be large (1.08 kg), however, and the total yield for both species was 0.30 ± o.23 kg/ha.

These estimates differ greatly from those collected during previous creel census work on the lake during the winters of 1976, 1977, and 1978, as part of the Lakeshore Capacity Study. Winter angling effort was then estimated to be 45.8 angler-hrs·ha^{-1} and the winter harvest was 1.74 kg·ha^{-1}. The present effort is 12% of the former, and present yield amounts to 17% of that of 1976, 1977, and 1978. Catch-per-unit-effort has apparently increased, from 0.04 kg·ha^{-1}·angler hour^{-1} to 0.06 kg·ha^{-1}, but it remains low in comparison to the other lakes on which censuses were conducted.

The total winter harvest amounted to 121 ± 54 lake trout and 10 ± 4 whitefish. Catches of other species were of negligible size.

Loftus, D. H. and S. R. Rubie. 1982. The Koshlong Lake creel census, 1981. Manuscript Report. Haliburton-Hastings Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Bancroft, Ontario. 13 p.

Koshlong Lake, Glamorgan Township, is a lake trout-smallmouth bass lake supporting active fisheries for both species. Lake trout were introduced to Koshlong Lake in 1956 and maintenance stocking has continued to the present time. There is presently no firm evidence that significant natural recruitment of lake trout occurs.

The Haliburton-Hastings Fisheries Assessment Unit conducted creel censuses on the lake from January 1 to March 31, 1981 and from June 1 to October 9,

1981. The purpose of the creel censuses was to estimate fishing effort and success, and to obtain biological data from harvested fish.

Confidence limits around effort and yield estimates are unacceptably large. The principal sources of variation are the party count data and data on fish weights. Estimates derived from such data may be more precise than confidence limits suggest but frame surveys are necessary to establish what level of precision is actually being achieved.

The MEI yield for Koshlong Lake is estimated at 2.25 $kg \cdot ha^{-1} \cdot yr^{-1}$.

The known lake trout yield for Koshlong Lake in 1981 was 1.25 $kg \cdot ha^{-1} \cdot yr^{-1}$. This estimate does not include the yield during spring. The total lake trout yield was probably at least 1.50 $kg \cdot ha^{-1} \cdot yr^{-1}$, or 67% of the "MEI yield" of 2.25 $kg \cdot ha^{-1} \cdot yr^{-1}$. A yield of this magnitude is consistent with a put-and-take lake trout fishery, but is probably excessive if the objective of stocking is spawning stock rehabilitation.

Winter caught lake trout tended to be much smaller than summer caught lake trout. In Koshlong Lake, small lake trout are probably more vulnerable to winter fishing because of its passive mode and the small baits employed. Anglers had better success at catching large trout in the summer even after partial depletion of their numbers by the winter fishery.

Mills, K. H., S. M. Chalanchuk, and D. J. Allan. 2002. Abundance, survival, and recruitment of unexploited and exploited lake charr (*Salvelinus namaycush*) populations at the Experimental Lakes Area, northwestern Ontario. Environmental Biology of Fishes 64 : 281-292.

We studied abundance, annual survival, and recruitment of nine lake charr (*Salvelinus namaycush*) populations at the Experimental Lakes Area, Ontario, for periods of 9-24 years. We used the Jolly-Seber mark-recapture method to evaluate abundance and annual survival in all populations, and total catches of individual year classes to evaluate recruitment. Seven populations were unexploited and unaffected by whole-lake experiments. One population was exploited prior to mark-recapture study and another was affected by experimental acidification. Abundance ranged from 8 to 24 fish ha^{-1} in the unaffected populations. Annual survival ranged from 78% to 93% yr^{-1} in all populations except the exploited population. This population may have been additionally affected by northern pike (*Esox lucius*) predation. Yearly recruitment was relatively constant in all populations and related to lake charr abundance. Lake charr abundance did not recover in populations affected by exploitation or acidification. Unexploited lake charr populations were characterized by relatively constant abundance, high annual survival, and relatively constant annual recruitment.

Martin, N. V. 1953. The creel census and fish management in Algonquin Park, 1951 and 1952. Ontario Department of Lands and Forests. Whitney, Ontario. 7 p.

Since 1935 data have been recorded for a number of Algonquin Park lakes on the species of fish caught, their number, size, and ease of capture. Besides being of general interest to the fishermen these data are of value in following and

assessing changes in the quality of fishing in these lakes and may serve as the basis for a management programme for the Park area.

The completeness of the census returns varies from those lakes where only scattered records are obtained to those such as Opeongo where at least 85 percent of the fish caught have been recorded, and a large number examined.

In 1951 and 1952 no census takers were established in the Cache Lake area and returns are considerably less in the southwestern part of the Park in these years. This is in line with the policy of concentrating the limited census staff on certain specific lakes rather than attempting to cover the whole Park area as has been done in the past. The latter, although of general interest in showing the general trend in fishing quality in the Park, does not permit the detailed analysis of individual fisheries. It is hoped by a more complete census on particular lakes, along with the collection of certain biological material as scale collections, to assess the value of various management practices now in use and also to serve as a basis for the institution of new ones.

The alternate lake closure of Algonquin Park lakes was first put into effect in 1938 and has been consistently expanded since that time until about half of the lakes are now closed each year. The program was instituted when fishing returns indicated a large part of the spawning stock of trout was being removed by angling from some heavily fished lakes each year.

By closing the lakes in alternate years, trout that would normally fall prey to the angler would spawn in the closed years and ensure future fish production. As far as can be seen at the present time results indicate that the plan has had no appreciable effect on the strength of year classes. However, the year classes now being captured by anglers are the result of spawning during the war years when fishing was light. Fishing pressure has increased since 1945 and the real value of the closure will be apparent in the next few years.

Alternate closure has helped a number of lakes and has sustained fishing quality in some of the more accessible and popular trout fisheries.

In addition to the foregoing, certain management practices are being attempted on an experimental basis. Cache, Kearney, Brewer, and MacCauley lakes have been fertilized over a period of years to determine the feasibility of adding chemical fertilizer to increase growth and abundance of game fish. Early results indicate the fertilizer has increased the growth and abundance of some of the fish trout use for food, but as yet there is no indication of any major changes in the trout population themselves.

Martin, N. V. and F. E. J. Fry. 1972. Lake Opeongo: Effects of exploitation and introductions on salmonid community. Journal of the Fisheries Research Board of Canada 29 : 795-805.

Lake Opeongo, a 58.6 km^2 lake in the highlands of Algonquin Park, Ontario, has been under study since 1936. Due to little human development of the area,

environmental conditions have been stable but because of its geological setting and location the lake waters are relatively unproductive.

The smallmouth bass introduced in 1928 has had no apparent major impact on the salmonid community but has served to buffer fishing pressure on the lake trout. The cisco introduction in 1948 resulted in faster growing, better conditioned and more fecund lake trout but has also contributed to their later maturity. Weight production of trout increased and in recent years stronger classes have apparently resulted from the improvement in fecundity. Declines in the perch and benthic insects and a decrease in the growth rate of certain fishes since the mid-1950s are apparently related to the cisco introduction.

Harvest of lake trout by the sport fishery has varied from 630 to 2,700 fish/year representing a long term yield of 0.33 kg/ha. Mean total mortality rate is 50% per year and exploitation has served to double the mortality rate after the trout have entered the fishery. Year-class production is correlated with spawning escapement and exploitation has limited recruitment to the trout population.

Martin, N. V. and C. H. Olver. 1980. The lake charr (*Salvelinus namaycush*), p. 205-277 *In* E. K. Balon [ed]. Charrs – salmonid fishes of the genus *Salvelinus*. W. Junk Pub, The Hague, The Netherlands.

This paper is an indepth review of the life history of the lake trout covering subjects such as: form, anatomy and distribution, reproduction, life history, ecotope, population dynamics, harvest recruitment and mortality.

The lake charr is extremely sensitive to exogenous, man-induced perturbations. It is essential that pristine conditions be maintained for the well-being of this species. In addition to threats such as pollution, mining, agricultural and forestry practices, power development schemes, introduction of exotics and shoreline development, the lake trout is highly susceptible to overexploitation. Harvests from lake charr lakes are limited because in most cases nutrients are low, growing seasons are short and temperature regimes low. Related to this and contributing to the lake charr's vulnerability to overfishing are the inherent slow growth and late maturity of the species.

Also stated within the paper's harvest section is an important observation that it is likely that most lakes are capable of sustained annual harvests of lake charr in the order of 0.25-0.75 $\text{kg}\cdot\text{ha}^{-1}$.

McKeown, W. J. 1970. McConnell Lake area creel census, 1969-1970. Manuscript Report. Ontario Ministry of Natural Resources. North Bay, Ontario. 2 p.

Results of 51 creel census days during the summer of 1969 and winter of 1970, in the McConnel Lake area, show 745 anglers fished a total of 1,965 hours for a catch of 1179 fish.

Total catch consisted of 800 brook trout, 108 lake trout, 252 pickerel and 19 smallmouth bass.

Of lakes containing hatchery-marked fish, 83% of the 1969 summer hatch were marked fish, while winter angling produced 87% marked fish.

McGurrin, R. 1977. 1977 summer creel census: Charleston, Red Horse, Singleton, and Lyndhurst Lakes. Manuscript Report. Ontario Ministry of Natural Resources. Brockville, Ontario. 82 p.

This report completes the 1977 Summer Creel Census for Charleston, Red Horse, Singleton and Lyndhurst Lakes.

Information was collected for this report from June 15, 1977 to August 28, 1977 using Ministry of Natural Resources Creel Form SF 150, and working on a pre-set schedule. The information collected deals with fish harvest, angling success, fishing pressure, stocking programmes and other related topics.

Charleston Lake – Twenty-five percent of the anglers fishing on Charleston Lake were residents of the local area (Brockville District). This means that 75% of the anglers came from out of the country, out of the province, or at least out of the local area.

The lake trout fishery is the most important in the lake taking up 4.19 rod-hours per acre of a total fishing pressure of 7.2 rod-hours per acre for all species. 344 of 653 anglers (53%) were seeking lake trout.

It is estimated in this report that 1,971 lake trout were caught during the three summer months with only 1,488 (75%) being retained.

Based on data collected, 68% of the trout caught were hatchery-reared fish, giving a return of 8.3% on the average yearly stocking over the last ten years.

For the first time, information was collected on the use of fishing accessories (i.e., depth finders) showing that only 12% of the anglers used them. Those 12% however, accounted for 30% of the lake trout harvested.

Red Horse Lake – Seventy-five percent of the anglers on Red Horse Lake were from outside the Brockville district with 90% of those being from outside the country.

Bass fishing was the most important fishery taking up 9.9 rod-hours per surface acre out of a total of 13.4 rod-hours per acre for all species. Bass anglers totalled 165 of 255 (73%) creeled anglers.

An estimated 38 lake trout were caught giving a return of 0.7% on the trout stocking programmes.
Singleton and Lyndhurst Lakes were primarily fished for bass and had no lake trout statistics were presented.

Micklus, R. C. 1959. Sport fishing harvest of the lake trout fishery on West Pike Lake, Cook County. Investigational Report No. 222. Minnesota Department of Conservation. St. Paul, Minnesota.

Micklus, R. C. 1959. Final report of a three year creel census on a lake trout sport fishery on Mountain Lake, Cook County. Investigational Report No. 207. Minnesota Department of Conservation. St. Paul, Minnesota.

Mohr, L.C. and S. Milne. 2001. The status of lake trout (*Salvelinus namaycush*) in Canadian waters of Lake Huron. p. 95 *In* Great Lakes Science, Making it Relevant: Abstracts from the 44th Conference on Great Lakes Research, June 10-14, 2001. International Association for Great Lakes Research. Green Bay, Wisconsin.

Lake trout (*Salvelinus namaycush*) were almost extirpated from Lake Huron in the 1940s. By 1959, virtually no lake trout were reported harvested from all waters of Lake Huron. Rehabilitation attempts in Canadian waters have involved the stocking of various strains of lake trout, splake, and backcross lake trout. A lake trout rehabilitation plan for the Canadian waters of Lake Huron was finalized in 1996 and assessment of rehabilitation efforts have been conducted by the Lake Huron Management Unit since. Data presented are collected from independent assessment index projects, commercial catch sampling programs and recreational index surveys. Several factors may inhibit the rehabilitation of lake trout in Lake Huron. Targetted and incidental commercial and recreational exploitation and sea lamprey predation will be addressed in this paper. Commercial exploitation in Lake Huron is strongly correlated with stocking rates in the lake and with lake whitefish (*Coregonus clupeaformis*) targeted fisheries. The mean age, age at maturity, and spawning population numbers all appear to be quite low compared to natural lake trout populations in other lakes. Exploitation, whether targeted or incidental, may be a limiting factor in the rehabilitation of lake trout in the Canadian waters of Lake Huron.

Mosindy, T. 1987. Lake trout studies, Clearwater Bay, Lake of the Woods 1984-1987. Lake of the Woods Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Kenora, Ontario. 44 p.

The lake trout fishery in Clearwater Bay exhibits signs of stress from overexploitation, primarily from winter angling. Both angling effort and harvest have grown from being virtually non-existent in the late 1970s to estimates of 15,500 man hours of effort and 2,400 kg of lake trout harvested in 1987. Current harvests equal yields of 0.78 and 1.04 $kg \cdot ha^{-1} \cdot yr^{-1}$ during 1986 and 1987, respectively. The estimated catch in 1987 represents an overharvest of 109% above the allowable yield for lake trout in Clearwater Bay.

Continued overexploitation and deterioration of lake trout habitat in Clearwater Bay will likely result in the loss of this naturally reproducing population.

Nesler, T. P. 1986. Prediction of ice fishing harvest of quality-size lake trout from previous gill-net sampling data. North American Journal of Fisheries Management 6(2) : 277-281.

Studies of lake trout (*Salvelinus namaycush*) population dynamics at Twin Lakes, Colorado, have been conducted since 1974 with a standardized design of gill-net sampling and with winter creel surveys. Quality-size lake trout were arbitrarily designated as fish at least 500 mm long. The percentage of these larger fish in

gill-net samples or in the angler harvest was used as an index describing the relative quality of the fishery. The indices derived from summer gillnetting and from the ice-fishing harvest on Lower Twin Lake fluctuated in a similar manner. Correlation and regression analyses of these two variables provided a predictive equation describing the percentage quality-size lake trout in the winter harvest from percentage of these fish in the preceding summer gill-net sample. The quality index for the 1982-1983 winter harvest was successfully predicted from the preceeding 7 years data. Quantifications of this relationship could provide an inexpensive means of monitoring a fishery oriented toward trophy fishing.

Olver, C. H. 1969. The 1969 Chiblow-Denman Lakes creel census report with a comparison of the 1967-1969 lake trout fishery. Manuscript Report. Sault Ste. Marie District. Ontario Department of Lands and Forests. Sault Ste. Marie, Ontario. 29 p.

Olver, C. H. 1971. The 1968 Flack Lake sport fishery. Manuscript Report. Ontario Department of Lands and Forests. Sault Ste. Marie, Ontario. 17 p.

A creel census was initiated on Flack Lake in 1968 and encompassed the entire fishing season from May 1- Oct. 10. Most of the anglers interviewed were Ontario residents (81.4% percent) and only 18.4 percent were citizens of the United States. The majority of the anglers were day-trippers (72.4 percent) and 22.8 percent were campers from the Semiwite Lake Provincial campground.

Most of the anglers used the park access to launch boats for trolling or to fish from the shore. Catch statistic estimates were computed for these anglers. The owner of the tourist camp and fishermen from a privately-owned camp on the lake provided monthly catch totals to the creel census clerk. The estimated catch of all lake trout anglers in 1968 was 1,863 fish at a total weight of 2,536.6 pounds. The yield was 1.079 pounds-per-acre. The catch-per-unit-effort season average was 0.189 fish per man hour.

The average total length of the lake trout sampled was 16.6 inches and the average round weight was 1.4 pounds. The largest lake trout reported caught weighed 20.0 pounds.

Females were more prevalent than males as 315 fish (56.0 percent) were females and 247 fish (44.0 percent) were males. Male lake trout first attain sexual maturity at age V+ and females probably at age VI+.

The catch was dominated by age V fish (51.2 percent) and age VI fish, which together formed 84.9 percent of the aged sample. Age IV and age VII fish comprised only 6.9 and 5.3 percent of the catch respectively. The average age of the 608 fish sampled was 5.6 years.

Lake trout in the 15 inch (22.7 percent), 16 inch (26.1 percent), and 17 inch (19.2 percent) classes were the dominant inch groups in the catch and together they formed 68 percent of the sample. The 6 inch size range between 14.0 and 19.9 inches contained 92 percent of the fish examined. Forty-eight percent f the observed catch weighed between 1.0 and 1.4 pounds and fish less than 2.0 pounds formed 87.7 percent of the sample.

Only one of 642 lake trout examined by the census clerk was fin clipped. This fish was from the 1964 plant and the estimated number of fish of the 1964 plant captured in 1968 was 3. The percentage return was 0.06. No lake trout from the 1965 or 1966 plants were observed in the creel census.

Olver, C. H. 1971. The 1969 lake trout sport fishery – Semiwite Lake with a summary of angling results, 1968-1969. Manuscript Report. Sault Ste. Marie District. Ontario Ministry of Natural Resources. Sault Ste. Marie, Ontario.

The second year of a five year creel census project was competed in 1969. Data are presented for the 1969 fishing season and angling results are summarized for the past two years. Catch-effort estimates for 1969 were slightly greater than those realized in 1968. The 1968 season estimates (May 1- Oct. 10) were 617 lake trout at a total weight of 583.5 pounds or 0.776 pounds-per-acre. The 1969 season estimates (May 1- Sept. 10) were 722 lake trout at a total weight of 635.3 pounds or 0.845 pounds-per-acre. The catch-per-unit-effort increased from 0.227 fish per man hour in 1968 to 0.254 in 1969.

The estimated catch of the 1964 plant in 1968 and 1969 was 10 fish or 0.20 percent of the number stocked in 1964. The estimated catch of the 1965 plant in 1968 and 1969 was 5 fish or 0.17 percent of the number released in 1965. No lake trout from the 1966 plant were recorded in either 1968 or 1969.

Olver, C. H. 1971. The 1971 lake trout sport fishery – Semiwite Lake with a summary of angling results, 1963-1971. Manuscript Report. Ministry of Natural Resources. Sault Ste. Marie, Ontario.

The fourth year of a five year creel census project was completed in 1971. Data are presented for the 1971 fishing season and catch-effort statistics are summarized for the four year period 1968-1971. The age, size and weight composition of the catch was analyzed for the years 1963, 1965, and 1968-1971. The contribution of three different plants of hatchery-reared lake trout to the sport fishery was also determined.

Fishing pressure was quite constant between 1968 and 1970 but decreased 16 percent in 1971 to 2,361 man hours compared to the three year average of 2,811 man hours. The rate of success (catch-per-unit-effort) increased annually from 0.227 fish per man hour in 1968 to 0.254 in 1969, 0.271 in 1970, and 0.317 in 1971. The catch increased from 617 fish in 1968 to 722 fish in 1969 and declined to 694 fish in 1970 and 679 fish in 1971. The estimated yield (pounds-per-acre) was 0.776 in 1968, 0.845 in 1969, 0.650 in 1970, and 0.697 in 1971. The four year average was 0.742 pounds-per-acre.

Lake trout age VI and older have been replace by fish age V and less in the angler's catch. Fish age VI and older formed 86.8 percent of the catch in 1963 but only 10.8 percent in 1971. Fish age V and less formed only 13.2 percent of the catch in 1963 compared to 89.1 percent in 1971. The age of maximum vulnerability decreased from VI to IV. Lake trout less than 16 inches replaced larger fish in the catch and formed 89.9 percent of the catch in 1971 compared to only 17.6 percent in 1963. Most of the fish caught since 1968 have weighed less

than one pound and the percentage of fish less than one pound increased from 5.9 in 1963 to 74.8 in 1971. The changes in age, size, and weight composition of the catch are attributed to the effect of angling on the lake trout population.

The catch of hatchery-reared lake trout has been negligible. The total estimated catch of the 1964 and 1965 plants was approximately one quarter of one percent each. No fish from the 1966 stocking have been reported through 1971.

Olver, C. H. 1972. The status of the lake trout (*Salvelinus namaycush*) in the northeastern region: Problems and policy. Manuscript Report. Sault Ste. Marie District. Ontario Ministry of Natural Resources. Sault Ste. Marie, Ontario. 18 p.

The basis of this report is the belief that overexploitation has occurred and is presently occurring on many lake trout lakes in the northeastern region. Strong measures are necessary to rectify this situation and to ensure the continued existence of high quality lake trout fisheries in the presence of increasing recreational demands. To propose a less stringent course of action would be perhaps an abrogation of our responsibilities to present and future generations of Ontario citizens.

Recommendations are as follows:

- The number of lake trout lakes included in the annual lake survey and updating program should be increased in order to attain adequate lake survey data on all lake trout lakes as soon as possible.
- Management must be concentrated on maintaining quality fishing on the prime lake trout lakes in each district.
- A regional policy for area, quota, and individual lake management, while premature at this time, should be the goal of the Northeastern Region. The onus to initiate change is the responsibility of the individual districts.
- The Ontario Government should enter into discussions with the Federal Government at the highest level for the express purpose of acquiring complete control of all aspects of our fisheries, which are a Federal responsibility.
- There should be separate seasons for winter fishing and open-water fishing for lake trout in Division 18. The open season for winter fishing in Division 18 for lake trout should be restricted to a period of one month. The winter season should be, February 1- February 28, February 15- March 15 or March 1- March 31. The open-water season for lake trout in Division 18 should commence on, the opening date for pickerel in Division 18 or the Saturday preceding the legal Monday holiday in May. The open-water season should then close on the last Sunday in September or September 30.
- The daily catch limit for lake trout in Division 18 should remain at three fish.
- The open season for winter fishing in Division 19 for lake trout should be February 1- March 31.
- The open-water season for lake trout in Division 19 should commence on the Saturday preceding the legal Monday holiday in May, and close on the last Sunday in September or September 30.

- The daily catch limit for lake trout in Division 19 should be reduced from 5 to 3 fish.
- Districts should continue to use sanctuary status on individual lakes or groups of lakes as local conditions require.
- A regional policy is required to regulate shoreline development and allocation of land use permits. Input from Fish and Wildlife Branch at the initial stages of any land and water development proposals on Crown land should be mandatory.
- The policy should be formulated by regional staff of the Outdoor Recreation Division and the Land Management Division.
- District Fish and Wildlife staff request that the following be included in this policy:

    - Any proposed developments on lake trout waters so designated by the district Fish and Wildlife Supervisor be immediately withdrawn.
    - No future developments occur on lake trout lakes except with the approval of the district Fish and Wildlife Supervisor.

- The best corrective measure to improve lake trout plantings for supplementing natural reproduction is to stock larger fish than are currently produced as yearlings. Lake trout should average 20 fish per pound when planted.
- Use low density stocking rates of yearling lake trout for introductory plantings.
- If necessary, impose sanctuary status to avoid excessive fishing pressure on introduced populations until such populations are established through natural reproduction.
- Put-and-take fisheries for lake trout should not be permitted.
- Splake should not be planted in waters which contain natural lake trout populations and lake trout introductions pr plantings should not occur in any lake which is managed for splake sport fishing.
- Splake should continue to be considered as lake trout for the purpose of regulations.

Ontario Ministry of Natural Resources. 1983. The identification of over-exploitation. Report of Strategic Planning for Ontario Fisheries Working Group Number 15. Ontario Ministry of Natural Resources. Toronto, Ontario. 84 p.

Changes which fish stocks undergo when exploited are reviewed and a selection is made of responses, which have practical application as indicators of stress. These fall into three categories: (1) effects relating to population size; (2) those relating to population structure; and (3) a final group relating to physiological processes. The last of these represent the major mechanisms for compensation. This report is based on the proposition that stress from exploitation can be ascertained from the degree of change (all else being equal) and that tolerance to increased fishing will be a function of the scope for additional compensation.

This report outlines practical means by which the severity of the fishing stress may be examined. It has two thrusts. One is to advance a line of reasoning – in essence, to raise questions or issues that should be asked or considered in any

analysis of fishing impact. The other is to specify parameters and procedures for quantifying fishing effects and some benchmarks for reference when interpreting results.

Palilionis, A. P. 1978. Buck Lake creel report. Manuscript Report. Ontario Ministry of Natural Resources. Napanee, Ontario. 28 p.

A summer creel census program was carried out during May, June, and July of 1978. During this creel period 380 anglers were censused and 82 gamefish sampled. The estimated monthly fishing efforts for the months of May, June and July were 4,530, 3,875, and 10,895 man hours, with respective fishing pressure estimates of 6.09, 5.21, and 14.65 man hours/ha.

Of the 82 gamefish samples, 44% were largemouth bass, 33% smallmouth bass, 17% northern pike and 6 percent lake trout. The estimated total harvest of gamefish for the creel period was 4,645 fish, at a total weight of 3,208 kg or 7,075 pounds.

Palilionis, A. P. 1978. Devil Lake creel census report. Manuscript Report. Ontario Ministry of Natural Resources. Napanee, Ontario.

A creel program was carried out on Devil Lake during the months of May, June and July of 1978. Total monthly efforts for May, June and July were estimated as being 5,387, 5,742, and 13,553 man hours respectively, during which time the estimated harvest amounted to 3,813 gamefish. Of these 39.5% were lake trout, 28.7% were largemouth bass, 24.8% were smallmouth bass and 7.0% were northern pike.

The catch-per-unit-effort (CUE) for lake trout for the creel period was 0.095 with a high of 0.149 occurring during the latter half of June. The CUE for all gamefish rose throughout the summer from a low of 0.07 to a high of 0.211. The CUE for the summer was 0.142.

The lake trout population shows signs of stress, with a high percentage of the harvest being small, immature fish. However, the stocking program does not appear to be contributing to the fishery.

The total known harvest of all fish from Devil Lake is 8,068.42 pounds. Several months of the fishing season have been excluded from this estimate.

Palilionis, A. P. 1979. Lake trout winter fishery. Manuscript Report. Ontario Ministry of Natural Resources. Napanee, Ontario.

A creel census program was conducted on 9 lake trout waters in the Napanee District during the opening weekend of the lake trout season. During this time 665 anglers had fished for 2,517 hours and had caught 358 trout for a catch-per-unit-effort (CUE) of 0.142.

Five of these lakes were censused several times during the winter season. These lakes included Big Salmon Lake, Buck Lake, Devil Lake, Little Clear Lake, and Little Salmon Lake. A total of 536 anglers with 2,015 man hours were

interviewed and had a catch of 248 trout for a CUE of 0.12. Scale samples were taken from these fish for age determinations and comparison purposes.

Due to early spring conditions the ice-fishing season lasted only 18 days. Fishing pressure estimates were obtained through aerial head counts conducted during nine days (50%) of the ice-fishing season. These estimates were highest during the opening weekend and dropped off as the season continued and ice conditions worsened. During the 18 day season, lakes were estimated as receiving up to 32 man hours per hectare (13 man hours/acre), supporting our concern that these lakes are being overexploited.

The majority of harvest from all lakes was represented by small immature fish which by itself, supports our concern with overharvest. The returns of fin-clipped fish provided an opportunity to look at the success of stocking programs on these lakes, with high returns on those lakes with poor trout habitat.

Of all the lakes censused Buck, Canoe, Desert and Devil Lakes possessed the highest fishing effort and all had direct access by highway vehicles. This alone seems to be the one factor responsible for the number of anglers on these lakes. Of these four lakes, the lowest fishing pressure was exerted on the largest lake Devil) and the highest pressure on the smallest (Canoe). Fishing pressure and overharvest then respond in an inverse relationship to the size of the lake.

The analysis of the harvest results does support our concern with overharvest. Again the majority of the harvest is immature, undersized trout – much more so than during the summer. In the winter the nature of the fishing, (i.e. still fishing, and the use of small minnows such as dace) is more than likely responsible for capturing trout at 4 to 5 years of age when they just enter the fishery. The incidence of herring was relatively high with as many as 1 in 3 lines using this bait, however, the incidence of success was very low and was not responsible for the capture of small trout. The use of herring is, in fact, the only practical method of imposing a size limit on lake trout, in that small immature fish cannot be taken by this method. During the summer the majority of lake trout anglers fish by trolling, which attracts larger fish in higher year classes.

Payne, D. and K. Roche. 1984. 1982 winter creel survey northcentral region. Ontario Ministry of Natural Resources. Thunder Bay, Ontario. 58 p.

During the period from January 3 to April 3, 1982 a creel survey was conducted on 48 lakes in the Thunder Bay (22), Nipigon (8) and Atikokan (18) Districts. Pressure estimates indicate that the Thunder Bay District receives the greatest fishing pressure (19,885.69 man hours), however, the greatest proportion of the catch (2,405.86 kg) was taken from Atikokan lakes. The majority of pressure was exerted during the month of March and weekends were fished slightly more than weekdays. Catch-per-unit-effort (CPUE) varied considerably between lakes and districts with Nipigon lakes providing the best overall success at 0.22. The regional CPUE was 0.12 or 1 fish approximately every 8.3 hours. The mean weight of reported lake trout was significantly larger from Atikokan lakes (2.23 kg) than both Nipigon (1.00 kg) and Thunder Bay (0.92 kg) lakes. The majority of anglers were found to be local in origin (74%) with Ontario residents accounting

for 24% of the remainder. Only Atikokan showed any significant non-resident fishery at 18% of the district total.

Payne, N. R., R. M. Korver, D. S. MacLennan, S. L. Nepszy, B. J. Shuter, T. J. Stewart and E. R. Thomas. 1990. The harvest potential and dynamics of lake trout populations in Ontario. Lake Trout Synthesis Population Dynamics Working Group. Ontario Ministry of Natural Resources. Toronto, Ontario. 71 p.

A method for estimating the potential harvest of lake trout (*Salvelinus namaycush*) from a temperature-based volumetric measure of lake trout habitat is reformulated to increase its relevance to Ontario lakes and decrease data requirements. Arguments are given for choosing this method over the past practice of partitioning the MEI yield. Provincial standards for lake trout length-at-age and weight-at-length are developed for use in comparative studies of lake trout populations and stress diagnosis. An "empirical" method of estimating von Bertalanffy growth parameters is introduced to deal with problems of bias in lake trout length and age data. Fecundity, age at maturity, and natural mortality data are compiled as partial descriptions of these aspects of lake trout dynamics. A method of estimating optimal fishing mortality and size at recruitment from growth parameters alone is described; tables are developed which facilitate its application to lake trout; and the relevance of such an application is tested. The method is derived for yield-per-recruit theory and embraces a widely-held marine fishing policy. An age-structured model which integrates knowledge concerning habitat limitations with knowledge about internal population behaviour is also used to estimate the level of fishing mortality consistent with maximum sustainable yield. Sustainable yield curves developed with the model are asymmetric and show yields declining rapidly after a state of overexploitation is reached. Simulations of lake trout populations in "small", "medium" and "large" lakes suggest that populations in larger lakes are less vulnerable to overexploitation. Populations with total annual mortality rates (A) above 0.50 yr^{-1} are likely to be overexploited and in some instances even this level of mortality can be too high. Managers can reduce the vulnerability of lake trout populations to overexploitation by using size limits to delay the entry of year classes into the fishery.

Purych, N. A. 1973. The 1968-1972 lake trout sport fishery in Jimchrist Lake. Manuscript Report. Sault Ste. Marie District. Ontario Ministry of Natural Resources. Sault Ste. Marie, Ontario. 34 p.

The accessibility of this lake has resulted in substantial fishing pressure as evidenced by annual fishing intensities which varied between 4.53 and 10.44 man hours of effort-per-surface area. Fishing pressure in conjunction with extremely high catch-per-unit-effort (CUE) values in 1969 and 1970 produced excessive harvests in those years. Although CUE declined drastically in 1971 and 1972 and the fishing pressure decreased in 1971 and 1972 compared to the two other previous years, the estimated harvest in 1971 and 1972 was in the order of one pound-per-acre.

It is obvious that a catch of 70 to 140 lake trout averaging one pound each year would result in a yield of 0.5 to 1.0 pound-per-acre on this 143 acre lake. The

maximum sustainable yield for lake trout from Precambrian Shield lakes is considered by many Ontario biologists to be approximately 0.5 pounds-per-acre or less. The average estimated yield for the five years of the study on Jimchrist Lake was 1,713 pounds-per-acre. Although the 1970 yield was estimated at 4,138 pounds-per-acre it is believed that the actual yield in that year was closer to 3 pounds-per-acre. Consequently the average annual yield was probably 1.5 pounds-per-acre.

The increased age and size of lake trout caught in recent years suggests that angling has had an adverse effect on the lake trout population. These changes could also be caused by year class failures due to natural phenomena. Regardless of the cause of the present state of the fishery, it would not be prudent to reopen this lake to winter fishing.

Small sample size, particularly in 1971 and 1972, limits the conclusiveness of the evidence that the 1967 and 1968 year classes are weak, particularly in relation to the three previous year classes. Intensive angling may have depleted the spawning population resulting in a subsequent low rate of recruitment into the fishery. It seems safe to predict that the lake trout fishery in Jimchrist Lake will not be as productive in 1973 and 1974 as it has been in the past.

The shore fishery on Jimchrist Lake provides more angler-days, a higher success rate, and a higher harvest than does the boat fishery. Because this lake can be successfully fished from shore there is little reason to provide improve boat access at this time. Further, the banning of motor boats from this lake should be considered. The lake can easily be navigated by canoe or row-boat. Obviously, the susceptibility of this lake to pollution is increased by its small size and volume. A ban on motor boats would have the added benefit of decreasing harvest by excluding those anglers not willing to use other means.

One of the original intent of closing 6 lakes in Mississagi Park to winter fishing was to attract summer tourist dollars to Elliott Lake area. Jimchrist Lake is fished almost exclusively by local residents and in May before the park officially opens. It does not contribute to the tourist industry, and it essentially lies fallow during the summer months.

Increased fishing pressure on lake trout during any part of the year is not to be encouraged but the possibility of establishing an alternate species to provide summer angling recreation could be considered.

Recommendations for Jimchrist Lake include the continuation of the policy on winter closure, the discontinuation of lake trout stocking, and the prohibition of the use of outboard motors.

Purych, P. R. 1976. The lake trout (*Salvelinus namaycush*) fishery of Flack Lake. Manuscript Report. Ontario Ministry of Natural Resources. Blind River, Ontario. 58 p.

The analysis of the seven years of creel census data from Flack Lake has resulted in a significant insight into the lake trout fishery there. It is apparent that with the intensive fishery and high yields being realized during the summer

months that a winter closure policy is justified. The contribution of hatchery-reared lake trout has been found to be negligible and further plantings should not be initiated. Symptoms of over-exploitation have started to appear in recent years and it is assumed that these are due to the excessive yields being achieved. Therefore, in an attempt to stabilize the fishery, initial recommendations have been made which are directed at reducing the harvest. To be specific, it has been recommended that the current season closure date be extended to the end of May along with a reduction in the daily limit from 3 to 2 lake trout.

Rawson, D. S. 1961. The lake trout of Lac la Ronge, Saskatchewan. Journal of the Fisheries Research Board of Canada 18(3) : 423-461.

The lake trout (*Salvelinus namaycush*) of Lac la Ronge was studied in the years 1948 to 1959 using gill netting, tagging, creel census and sampling the spawning run.

By diverting commercial fishing from trout to whitefish the average commercial catch in the 10-year period has been maintained at 250,000 lbs per year, as compared to 316,000 lbs in the previous 30 years. The angler's catch of trout now averages 30,000 lbs per year and this could be doubled without exceeding the known capacity of the lake for trout production. The creel census shows no decrease in average size of trout caught, average catch per angler, and number of very large trout taken.

Regier, H. A. and K. H. Loftus. 1972. Effects of fisheries exploitation on salmonid communities in oligotrophic lakes. Journal of the Fisheries Research Board of Canada 29 : 959-968.

In many oligotrophic lakes intense fisheries exploitation preceded severe cultural eutrophication by several decades at least, except perhaps in stream and inshore areas. Attempts to infer the effects of exploitation from historical fisheries data must allow for the high rates of capture associated with the "fishing-up" process that follows initiation of a new fishery, introduction of a new gear, change in capture or vessel technology, etc. The nature of the fishing-up process is examined in some detail. Interactions of new introduced species and of eutrophication with overexploitation are also outlined.

Within the salmonids, different taxa appear to respond somewhat differently to exploitation stress than others. Responses of the taxa are examined in the context of well-known properties of their niches and population variables.

Some inferences concerning responses at the community level are proposed. Compensatory capabilities seem directly related to the degree of eutrophy of the lake. Events such as the virtual disappearance of taxa, or eruptions of new taxa, and the relative variability in year-class abundance of the dominant taxa, are examined in this context.

Ridout, G. 1981. Winter creel census Sharbot Lake (west), 1981. Manuscript Report. Ontario Ministry of Natural Resources. Sharbot Lake, Ontario. 21 p.

A winter creel census was conducted on Sharbot Lake west during February 1981. Data collection showed that 172 anglers fished 645 man hours to catch 50 lake trout, resulting in a catch-per-unit-effort (CUE) of 0.078. Herring, as bait, was found to catch less fish than other baits, but had a comparable CUE when dealing with weight of fish caught. The weight of fish harvested per hectare was 0.7 kg during the winter fishery.

Hatchery stocked fish are very important to the Sharbot Lake west fishery. This years figures indicate 47.9% of fish kept are from hatchery stock. Increase in angling pressure and reduction in total harvest from last year may indicate the necessity for more fish being stocked in future years or a change in creel limit.

Ritchie, B. 1992. Squeers Lake experimental fishery, 1982-1991: Progress report with recommendations. Quetico-Mille Lacs Fisheries Assessment Unit Report No.1992-1. Ontario Ministry of Natural Resources. Mille Lacs, Ontario. 46 p.

This report summarizes the results of an ongoing experimental management project to determine:

1. The allowable yield of naturally-reproducing lake trout;
2. The best assessment methods for measuring the status of lake trout populations relative to exploitation stress;
3. The effectiveness of a pulse fishing strategy for managing lake trout for sustainability.

A review of progress to date with respect to pulse fishing should be completed as soon as possible. There is also a need to ensure a control is being monitored to assist in interpretation of the Squeers Lake results and result obtained from pulse-fished lakes. Also, a review of six Thunder Bay lakes located near Squeers Lake as potential candidates for a pulse fishing experiment should be done as soon a possible. This review should be coordinated by the Northwest Region Science and Technology Unit.

The experimental fishery target of 2.0 to 2.5 kg/ha has been reached in five consecutive years (1988 to 1992-preliminary results). While we are monitoring for population responses to changes in total mortality and density, recruitment effects will lag by at least 7 years. It has been determined that, due to the high mean age of the population and the large number of pre-productive year-classes, there may be a significant lag in compensatory responses to exploitation. To examine stock-recruitment for at least 3 year-classes at each harvest level we would need to maintain the current harvest level until 1988 to 1990 year-classes will be recruited. This information plus biological characteristics currently being monitored will provide direction on whether the harvest level should be increased for 1999.

Ryder, R. A. 1957. Winter fishing pressure on lake trout, Port Arthur District, 1957. Manuscript Report. Ontario Department of Lands and Forests. Thunder Bay, Ontario. 4 p.

From January to April 1957, a winter fishery survey was conducted on 19 lakes in the Port Arthur District subject to the heaviest angling pressure for lake trout. The purpose was to make a preliminary estimate on the number of lake trout harvested through winter angling. Many local sportsmen did not believe that lake trout should retain a year-round open season. As lake trout is harvested much more easily during the winter months the sportsmen preferred legal bag limits to be the rule rather than the exception. From the results, it seems probable that the subsequent harvest is at least ten times greater than that of the winter anglers. It seems unlikely that lake trout are being over-exploited at this time. Winter angling does not overexploit the lake trout population in the Port Arthur District at the present time under existing fishing pressure. The winter harvest of lake trout constitutes only a small portion of the annual catch. Decrease in the quality of fishing in local trout lakes is usually associated with the introduction of an undesirable fish species, or some other alteration of the habitat, and not by winter angling.

Ryder, R. A. and L. Johnson. 1972. The future of salmonid communities in North American oligotrophic lakes. Journal of the Fisheries Research Board of Canada 29 : 941-949.

Predictions are made pertaining to the status of salmonid communities in North American oligotrophic lakes in the year 2000. It is assumed that man-induced effects such as eutrophication, exploitation, and introduction of exotic species will continue to increase at an exponential rate. The influence of forest fires, domestic and industrial water pollution, road development, pulp mills, mines, pipe-lines, air pollution, agriculture, power development, summer resorts, angling, commercial and subsistence fishing, diversions and introductions of both salmonids and other species is discussed. It is concluded that at the present rate of interference of the oligotrophic environment by man, salmonid communities will be reduced to insignificant levels within the next 30 years.

Salar, P. 1985. Lake trout winter creel census, Bay Lake. Fisheries Management Report 1985-08. Ontario Ministry of Natural Resources. Bancroft, Ontario.

In the winter of 1984, a conservation officer checked 279 anglers on Bay Lake. The anglers fished for 846.5 man hours and caught 26 lake trout (*Salvelinus namaycush*), of which 73 % were natural fish.

All estimates are calculated using a 95% confidence interval. The catch-per-unit-effort was 0.03 with and estimated total angling pressure per hectare of 55.1 ± 10.4. The estimated total winter lake trout harvest was 145 ± 27 kg or 2.2 ± 3.6 kg·ha.

Ninety percent of the anglers checked were from the Bancroft area.

Samis, W. G A. 1968. A winter creel census on Ranger Lake, 1968. Manuscript Report. Ontario Department of Lands and Forests. Sault Ste. Marie, Ontario. 17 p.

The estimated fishing pressure for the winter and summer, as defined by the census periods, was 1,037.2 and 3,229.9 man hours respectively. The combined

value was 4,267.1 man hours and the fishing intensity was 0.79 man hours of effort-per-surface acre. Although fishing pressure more than tripled during the summer months the catch-per-unit-effort decreased from 0.256 fish-per-man hour in winter to 0.089 fish per man hour during the summer. The estimated winter catch was 240 fish at 174.3 pounds and the summer catch was 282 fish weighing 394.8 pounds. The combined yield from the winter (0.032lbs/acre) and summer (0.073 lbs/acre) fishery was 0.105 lbs/acre.

No fish of hatchery origin were observed during the winter and summer creel census. Lake trout caught during the winter averaged 13.4 inches in total length and 0.7 pounds in weight. Summer-caught lake trout averaged 17.3 inches and 1.4 pounds.

Age groups IV, V, and VI supported the winter fishery with 84.0% of the observed catch whereas the summer fishery was supported by age groups V, VI and VII, which formed 85.5% of the aged sample. The average age of winter-caught lake trout was 4.9 years compared to 6.2 years for summer-caught fish.

The winter fishery was characterized by a high catch-per-unit-effort and the exploitation of smaller and younger fish than the summer fishery. Any significant increase in winter fishing would warrant additional study.

Samis, W. G. A. 1968. Wakomota Lake winter angling fishery, 1968. Manuscript Report. Ontario Department of Lands and Forests. Sault Ste. Marie, Ontario. 6 p.

Schlesinger, D. A. and N. G. MacLean. 1983. The winter sport fisheries of Big Clear, Big Rideau, Big Salmon, Charleston and Devil Lakes, 1982. Rideau Lakes Fisheries Assessment Unit Report No. 6. Ontario Ministry of Natural Resources. Sharbot Lake, Ontario. 70 p.

On Big Clear Lake 134 anglers were interviewed during 7 sampling days. An estimated 8,896 rod-hours (47.5 rod hours/ha) were exerted during the 16-day open season. Weekend anglers accounted for 64.5% of the overall angling effort. The average weekend-day effort was three times greater than the average weekday effort. All angling effort was directed towards lake trout.

The observed catch-per-unit-effort of lake trout, both areas combined, was 0.085 trout/rod hour. The observed harvest-per-unit-effort was 0.064. These values are 29% and 33% lower, respectively, than values calculated for the 1981 winter season. Overall, an estimated 810 lake trout were caught, of which 611 were harvested.

The estimated total yield of naturally reproduced fish for the winter fishery is 1.92 kg·ha or 91% of the annual potential yield for all species (2.11 kg/ha). The estimated yield of native lake trout (1.92 kg/ha) is almost four times greater than the recommended maximum yield for the native lake trout population (0.53 kg·ha/yr) assuming that the population is stressed only by exploitation.

On Big Rideau Lake 278 anglers were interviewed during seven sampling days. An estimated 19,025 rod-hours (2.9 rod-hours/ha) were exerted during the 16-

day open season. Weekend anglers accounted for 60.2% of the overall angling effort. The average weekend-day effort was about 2.5 times greater than the average weekday effort. Of the 278 anglers interviewed, 277 were seeking lake trout.

The observed catch-per-unit-effort of lake trout, all areas combined, was 0.097 trout/rod hour. The observed harvest-per-unit-effort was 0.081. These values are 48% and 18% lower, respectively, than values calculated for the 1981 winter season. Overall, an estimated 1,832 lake trout were caught, of which 1,556 were harvested.

The estimated total yield of naturally reproduced fish is approximately 0.15 kg/ha or 4% of the annual potential yield for all species (4.15 kg/ha). The estimated yield of native lake trout (0.15 kg/ha) is only 14% of the recommended maximum yield for the native lake trout population of Big Rideau Lake (1.04 kg·ha/yr).

On Big Salmon Lake 53 anglers were interviewed during 7 sampling days. An estimated 2,896 rod-hours (19.6 rod hours/ha) were exerted during the 16-day open season. Weekend anglers accounted for 60.6% of the overall angling effort. The average weekend-day effort was about 2.5 times greater than the average weekday effort. All angling effort was directed towards lake trout.

The observed catch-per-unit-effort of lake trout, both areas combined, was 0.097 trout/rod hour. The observed harvest-per-unit-effort was 0.094. These values are 36% and 30% lower, respectively, than values calculated for the 1981 winter season. Overall, an estimated 265 lake trout were caught, of which 258 were harvested.

The estimated total yield of naturally reproduced fish for the winter fishery is 0.55 kg·ha or one fifth of the annual potential yield for all species (2.75 kg/ha). The estimated yield of native lake trout (0.55 kg/ha) is about 80% of the recommended maximum yield for the native lake trout population of Big Salmon (0.69 kg·ha/yr) assuming that the population is stressed only by exploitation.

On Charleston Lake 193 anglers were interviewed during 7 sampling days. An estimated 11,845 rod-hours (4.7 rod hours/ha) were exerted during the 16-day open season. Weekend anglers accounted for 57.9% of the overall angling effort. The average weekend-day effort was about twice as great as the average weekday effort. Of the anglers surveyed 189 of the 193 were seeking lake trout.

The observed catch-per-unit-effort of lake trout, both areas combined, was 0.200 trout/rod hour. The observed harvest-per-unit-effort was 0.120. These values are 17% lower and 1% higher, respectively, than values calculated for the 1981 winter season. Overall, an estimated 3,101 lake trout were caught, of which 1,668 were harvested.

The estimated total yield of naturally reproduced fish for the winter fishery is approximately 0.60 kg·ha or 17% of the annual potential yield for all species (2.11 kg/ha). The estimated yield of native lake trout (3.55 kg/ha) is about 67% the recommended maximum yield for the native lake trout population (0.89 kg·ha/yr) assuming that the population is stressed only by exploitation.

On Devil Lake 165 anglers were interviewed during 7 sampling days. An estimated 18,818 rod-hours (17.7 rod hours/ha) were exerted during the 16-day open season. Weekend anglers accounted for 62.5% of the overall angling effort. The average weekend-day effort was three times greater than the average weekday effort. Of the anglers surveyed 165 of the 164 were seeking lake trout.

The observed catch-per-unit-effort of lake trout, both areas combined, was 0.041 trout/rod hour. The observed harvest-per-unit-effort was 0.026. These values are 11% and 19% lower, respectively, than values calculated for the 1981 winter season. Overall, an estimated 886 lake trout were caught, of which 545 were harvested.

The estimated total yield of naturally reproduced fish for the winter fishery is approximately 0.63 kg·ha or 18% of the annual potential yield for all species (3.48 kg/ha). The estimated yield of native lake trout (0.63 kg/ha) is about 72% of the recommended maximum yield for the native lake trout population of Devil Lake (0.87 kg·ha/yr).

Seisennop, G. D. 1992. Survival, growth, sexual maturation, and angler harvest of three lake trout strains in four northeastern Minnesota lakes. Investigational Report No. 419. Fisheries Section, Fish and Wildlife Division. Minnesota Department of Natural Resources. St. Paul, Minnesota.

It was found through this report that without significant recycling (catch-and-release) of angler-caught fish on the more readily accessible and heavily fished Minnesota lake trout waters, it is unlikely that many of the stocked lake trout will survive to spawn even once, much less grow to a relatively large size (10-12 kg) unless size and harvest limits are imposed. In Birch Lakes, stocked lake trout are virtually fished out within 2 to 3 years.

Catching and releasing lake trout for sport was uncommon. Most of the lake trout released on these lakes are fish anglers consider too small to keep, though some angler keep fairly small fish (<500 g) preferentially, believing they taste better or contain fewer contaminants than larger fish. Lake trout lakes with easy access, such as Birch and Mayhew, are managed similarly to "put-grow-take" stream trout fisheries in Minnesota. The easy access, angling vulnerability, lack of catch-and-release, and illegal harvest all contribute to the susceptibility of these large lakes to overexploitation (loss of large fish, possible yield over-fishing with reduction in weight harvested). Because lake trout are so vulnerable, lakes with more difficult access should be considered for management as sustainable wild trout fisheries. Greater escapement to spawning size, achieved by reducing harvest, may result in the re-establishment of successful breeding populations in at least some of the stocked lake trout lakes. In Duncan Lake, because access is somewhat more difficult, more stocked lake trout may survive to maturity. However, due to slow growth, sexual maturity is delayed and the period of vulnerability to predation is prolonged.

Seisennop, G. D. 2000. Estimating potential yield and harvest of lake trout (*Salvelinus namaycush*) in Minnesota's lake trout lakes, exclusive of Lake Superior. Investigational Report No. 487. Minnesota Department of Natural Resources. St. Paul, Minnesota. 43 p.

Estimates of optimal thermal habitat volume (THV) for lake trout indicate that about 12 percent of the total lake volume of the average Minnesota lake trout lake has temperature and dissolved oxygen conditions considered optimal for lake trout growth and long-term survival in July and early August. Lakes for which optimal thermal habitat was limited by reduced oxygen concentrations (<6.0 mg/l) had an average mean depth of 7.6 m (N = 21) while lakes for which optimal thermal habitat was not limited by oxygen had an average mean depth of 12.1m (N = 79). The volume of optimum lake trout habitat may be more oxygen limited in August and September than in July, particularly in relatively small lakes. Oxygen depletion in the hypolimnion and metalimnion during mid-to-late summer is a result of natural lake processes in remote lakes, but the rate and extent of oxygen depletion may be increased by habitat degradation in more accessible and developed lakes.

Potential lake trout yield based on July THV averaged 1.51kg·ha^{-1}·year^{-1} and ranged from zero to 3.77. The range of these yield estimates was broader than the range of lake trout yields (0.37 to 1.01 kg·ha^{-1}·year^{-1}) derived from the morphoedaphic index (MEI). With few exceptions, lake trout yield and harvest data for most of Minnesota's lake trout sport fisheries is undocumented or greater than 15 years old, and is limited to the winter angling season, especially for remote lakes. Existing creel data indicates that some lake trout lakes may have been overfished in the past. There is, however, a continuing need to determine the use and status of Minnesota's lake trout populations because there is a continuing interest in lake trout angling in relatively remote lakes and more accessible lakes. Criteria for estimating lake trout thermal habitat quantity and quality need revision to account for differences in lake trout behaviour with respect to temperature and forage, especially in small lakes with simple fish communities. Until lake trout community dynamics are better documented or sustainable lake trout yields are determined empirically, the MEI and THV potential yield estimates are recommended as guidelines for evaluating observed lake trout yields and harvest levels.

Shuter, B. J., M. L. Jones, R. M. Korver and N. P. Lester. 1998. A general life history based model for regional management of fish stocks: The inland lake trout (*Salvelinus namaycush*) fisheries of Ontario. Canadian Journal of Fisheries and Aquatic Sciences 55(9) : 2161-2177.

Life history characteristics of 54 Ontario lake trout (*Salvelinus namaycush*) populations vary with differences in lake area (range 25-450 000 ha) and total dissolved solids (TDS) (ranges 15-180 mg·L). Populations from large lakes exhibit greater maximum sizes, greater ages and sizes at first maturity, lower natural mortality rates, and lower sustainable yields. Populations from high TDS lakes exhibit higher growth rates in early life, lower ages at first maturity, larger sizes at first maturity, and higher natural mortality rates. Angler catchability increases significantly at low population densities. With these relationships included and age-structured population model, we found that the fishing mortality

rate at maximum equilibrium yield ranges from $0.12 \cdot year^{-1}$ for a 100 ha, low TDS lake to $0.37 \cdot year^{-1}$ for a 10 000-ha, high TDS lake; the fishing effort level at maximum equilibrium yield ranges from 6.6 $angler\text{-}h \cdot ha^{-1} \cdot year^{-1}$ for a 100 ha, low TDS lake to 4.0 $angler\text{-}h \cdot ha^{-1} \cdot year^{-1}$ for a 10 000 ha, high TDS lake. Populations from small, low TDS lakes are more sensitive to overexploitation than populations from large, high TDS lakes. Easily measured, environmental correlates of life history characters may be common among fish species and are useful in developing exploitation guideline for populations that are not well studied.

Sutherland, C. and J. Lawrence. 1978. Summer creel census on Lake Simcoe, 1978. Lake Simcoe Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Sutton, Ontario. 45 p.

During 86 census days between May 1 and September 15, 1978, 1,967 anglers were interviewed for creel census statistics on Lake Simcoe. Catches were dominated by yellow perch (75.4%) and smallmouth bass (13.7%). The non-specific catch-per-unit-effort (CUE) was 0.77 fish-per-angler hour. It was estimated that 158,987 angler hours were spent to catch 131,504 fish. Harvest and CUE data were calculated by creel census area and by species. Smallmouth bass, yellow perch, lake trout and northern pike were most actively sought by anglers.

Information on party size, number of lines, angler origin and fish caught per angler and party are discussed. Suggestions are made for improving creel census design, methodology and data analysis.

Lake trout caught by anglers had a mean age, weight and total length of 7.8 years, 3.937 kg and 68.0 cm respectively. Sixty-nine percent of the lake trout caught by anglers were hatchery-reared fish. Hatchery-reared fish comprised 61% if the lake trout between 3 and 7 years old while older fish were more likely to be of natural origin.

Tallman, R. F., R. Ratynski, K. I. Howland, and G. Low. 2002. The biology and management of lake trout in Canada's northern Great Lakes. International Association for Great Lakes Research Conference Program and Abstracts. 45 : 117.

Canada's Northern Great Lakes include Lake Athabasca, Great Slave Lake and Great Bear Lake of the Mackenzie River drainage. This paper reviews the available information and current assessment-related research on lake trout (*Salvelinus namaycush*) in the Northern Great Lakes. As well, the present management regimes for the lakes are reviewed. Lake trout populations in the southern lakes were threatened as early as the 1940s. The Lake Athabasca fishery has undergone apparent crashes and recoveries over the duration of its life with the current state being one of severe decline. Great Slave Lake historically produced commercial catches of over 300,000 pounds of lake trout but the fishery collapsed in the western basin due to overexploitation. A trophy sport fishery survives in the eastern arm of Great Slave Lake due to strict conservation measures. Compared to the more southerly lakes, Great Bear Lake has apparently escaped population declines. Most fishing on the lake has been

for aboriginal subsistence and trophy sport fishing. Numerous lodges operate around the lake. However, there is only limited information available on which to base the stock assessment for this lake. Fisheries and Oceans Canada has projects currently underway to increase the available information to fishery management.

Thomas, E. R. 1979. Status of the Mijin Lake fishery and management recommendations. Manuscript Report. Ontario Ministry of Natural Resources. Wawa, Ontario. 24 p.

Historical data and highlights of the 1977 Mijinemungshing Lake summer creel census are presented. The estimated harvest of 0.782 kg·ha from June 5 to September 5, 1977 indicates that overharvesting may be occurring. Of the harvested lake trout sampled only 5.5% were mature. The majority of fish (54.4%) were age 5+. Seventy-seven percent of the angling parties interviewed used outboard motors to catch 98.1% of the total lake trout. When questioned as to the necessity of motors for angling 67.1% of the anglers would not return if motors were prohibited. A ban on the use of outboard motors and live baitfish is recommended.

Walker, V. 1979. Lake Manitou winter creel census, 1975-1978. Manuscript Report. Ontario Ministry of Natural Resources, Espanola District. Espanola, Ontario. 26 p.

The results of four years of creel census data from Lake Manitou are presented and compared.

Native fish constitute less than 20 percent of the total harvest. In 1976 and 1978 approximately 90 percent of the catch was of hatchery origin.

Fishing effort is highest in February. The month has the highest average success rate, January has the poorest.

Seventy-seven percent of the winter fishery is drawn from ages III, IV, and V. Growth in length and weight is almost linear in the younger age classes and tapers considerably with the onset of sexual maturity at age VI.

The survival rate for fish of age IV and older was determined to be 51.74 percent. A secondary analysis using catch-per-unit-effort resulted in an estimated 56.43 percent survival.

Walters, C. J., G. Steer, and G. Spangler. 1980. Responses of lake trout (*Salvelinus namaycush*) to harvesting, stocking and lamprey reductions. Canadian Journal of Fisheries and Aquatic Science 37 : 2133–2145.

Sustained yields, declines, and recovery of lake trout (*Salvelinus namaycush)* can be explained by a simple model that hypothesizes normal population regulation through density dependent body growth, coupled with depensatory lamprey mortality. The model indicates that either lamprey or fishing alone could have caused the Lake Superior decline, though they apparently operated in concert. The presence of depensatory lamprey mortality leads to a “cliff edge” in

the system's dynamics, such that catastrophic changes may be repeated in the future. It is not unlikely that Lake Superior is on the verge of a second collapse. Options for dealing with potential disasters include conservation harvesting policies, development of more sensitive monitoring indicators, and modified stocking policies that may speed the coevolution of a viable lamprey/ trout association.

Weidlein, W. D. and A. J. Cordone. 1965. Trout catch and angler use at Lake Tahoe in 1962. California Fish and Game 51(3) : 187-201.

Estimates of total use and catch were obtained by a joint California and Nevada creel census by boat, and at Cave Rock boat landing. Angler-hours and catches on censused days were expanded to monthly totals. Possible biases were examined and considered unimportant, although an underestimate of use and catch was indicated. Total use was 144,147 angler-hours (47,732 angler-days); this amounted to 1.2 angler hours per surface acre. The total catch was 20,018 fish, or 0.14 fish per angler-hour. About 60 percent of the catch was lake trout, with wild rainbow and planted trout comprising 21 and 17 percent respectively. Estimated yield, excluding planted trout, was 0.34 pounds per acre.

Weir, J. C. and N. V. Martin. 1961. Winter fishing committee report. Manuscript Report. Ontario Department of Lands and Forests. 9 p.

Yaremchuk, G. C. B. 1986. Results of a nine year study (1972-1980) of the sport fishing exploitation of lake trout (*Salvelinus namaycush*) on Great Slave and Great Bear lakes, Northwest Territories: The nature of the resources and management options. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1436. Winnipeg, Manitoba. 80 p.

Data from creel census, tagging, and experimental gillnetting at sport fishing lodges on Great Slave and Great Bear lakes are examined in order to ascertain the status of lake trout (*Salvelinus namaycush*) stocks in the lakes and develop a rationale for their management. Tag returns suggest that a small percentage of trout move long distances but the average movement is so small that the fish in different areas of the lake, exploited by different lodges, should be managed as separate stocks.

At most lodges age and length distributions of fish sampled from the catch shifted from large, old fish to smaller younger fish during the early seventies, but are now stabilizing.

Total instantaneous mortality rate, determined by analysis of catch curves derived from otolith growth zone data, varies widely between lodges and years. Recent estimates vary between 0.17 and 0.33. Instantaneous natural mortality rate is estimated at 0.09.

Density of fish older than 20 yr is estimated at 0.49 fish/ha for shallow inshore waters.

The lake trout in Great Slave Lake grow more quickly than those in Great Bear Lake, particularly at larger sizes. Lake trout in Great Slave Lake mature at ages

7-14 while those in Great Bear Lake mature at ages 10-16. Historical yields, particularly of extremely large fish from Great Bear Lake, exceed equilibrium yield predictions generated by a Ricker yield per recruit model. However, yields have decreased to approximately 0.4 kg/utilized ha on Great Slave Lake and approximately 0.3 kg/ha on Great Bear Lake, lower than the estimated maximum sustainable yields for inshore areas of 0.60 kg/ha for Great Slave Lake and 0.36 kg/ha for Great Bear Lake.

Effects of exploitation level on angling quality and possible alternate uses of the resources are discussed. A socio-economic study of the values of the resource to the various uses and limitation of aggregate yields to prevent management of the resources for short-term objectives are recommended.

Youngs, W. D. and R. T. Oglesby. 1972. Cayuga Lake: Effects of exploitation and introductions on the salmonid community. Journal of the Fisheries Research Board of Canada 29 : 787-794.

Lake trout comprise the dominant sport fishery of Cayuga Lake. The major portion of the lake is suitable for the lake trout. This species has been the subject of a longterm investigation. The population in Cayuga Lake is maintained by an annual stocking of 28,000 fish, which are identified to year-class by fin clip. There is virtually no natural reproduction in the lake as judged by fin clipped specimens taken by extensive sampling.

Man and lamprey are the two main potential causes of lake trout mortality in Cayuga Lake. At the present time a study is underway to develop methods of estimating the contribution each of these sources of mortality may have to total mortality. Preliminary estimates indicate that total mortality may vary on a yearly basis from 25 to 60%. Estimates of exploitation give minimum values of 4-10% per year. Actual exploitation may be of the order of 3-5 times greater. The minimum estimate would account for an average harvest of approximately 5,675 kg by the sport fishery in recent years.

Information on the harvest of lake trout in past times is very limited. If commercial harvest of this species was ever practised, there are no records on which estimates can be based. The lake apparently never had the reputation of being good for lake trout though three of the Finger Lakes (Canandaigua, Seneca, and Skaneateles) were exploited commercially. In Seneca Lake, set lines were popular in the early days for fishing and there may have been a moderate harvest for the purpose of supplying local hotels with fresh lake trout. Records from 1894 and 1895 listed commercial harvest of fish from Cayuga Lake as 9600 and 7100 kg. It was reported the commercial fishery on Cayuga Lake as consisting of 21 persons with handlines and two persons licenced to use spears.

Zimmerman, F. A. 1965. The Lake Manitou creel census, 1962-1965. Manuscript Report. Ontario Department of Lands and Forests. Espanola, Ontario. 8 p.

The popularity of Lake Manitou and its lake trout fishery is growing every year but the majority of fish taken are caught by a relatively small number of people. There is a small group of open-water fishermen that travel regularly to Lake

Manitou each year to troll for the lake trout. The group seldom fails to catch less than one lake trout and frequently they take home all they can carry. The 1963 summer creel census consisted, to a large degree, of this type of fisherman.

1965 winter creel census data supports the theory that Lake Manitou's lake trout fishery is sustained by the introduction of hatchery stock.

In 1965 there were 113 potential days for ice-fishing on Lake Manitou. Anglers were checked on 74 days or about 65% of the total time. It is quite probable that the angling pressure and success was comparable during the period not accounted for. A calculated total creel census for 1965 would then be 1,300 anglers, 2,550 hours, 1,600 fish of all species including 1,250 lake trout.

Zimmerman, F. A. 1967. The 1967 winter creel census, Lake Manitou, Manitoulin Island. Manuscript Report. Ontario Department of Lands and Forests. Espanola, Ontario. 5 p.

Lake Manitou is probably the district's most important lake trout fishery. It is one of the province's sources of lake trout eggs. It supports an intensive sport fishery, and in recent years it has supported an increasing Indian commercial fishery.

The 1967 winter creel census indicated an obvious drop in lake trout catch despite an effort comparable to that of 1966. There may be several factors involved in this drop.

- An increase in Indian netting.
- An increase in the intensity and success of the summer fishery.
- A change in behaviour of the winter fisherman (from the southwest end of the lake to the northeast – from a Williams wobbler to a jig).
- The limit on Lake Manitou was dropped from 5 to 3 lake trout per day commencing January 1st, 1967. (few fishermen were observed to take their limit in 1967).
- The new type of bait (the jig) may be selective towards larger fish.
- The 1964 plant of 26,900 and the 1965 plant of 10,000 did not respond in the manner that the plantings of the previous two years did.
- Environmental conditions may have differed in 1967. The previous winter was an open winter with relatively little snow cover on the ice. The winter of 1967 was long and snow accumulations were high.

It would appear that naturally reproduced fish provide about the same level of fishing – 1.3 natural lake trout per 100 rod hours in 1966 compared to 1.4 in 1967.

At the present time it is too early to determine the effects of the different planting rates although there appears to be an obvious difference in the success of different year plantings.

Zimmerman, F. A. 1968. Lake Manitou winter creel census 1962-1968. Manuscript Report. Ontario Department of Lands and Forests. Espanola, Ontario. 5 p.

In 1968, during 36 days of census, 970 anglers were checked. These anglers fished for 4,600 hours catching 1,386 fish of which 260 were lake trout. This indicates a marked change from the 125 anglers checked in 1962 who angled for 627 hours and took a total of 123 fish of which 55 were lake trout. The catch in trout per 100 rod-hours has varied from 50 in 1963 to 5 in 1967. Plantings of yearling trout vary from 10,000 in 1965 to 65,000 in 1968.
It is recommended that the winter creel census be continued as a means of detecting any further changes in the lake trout fishery, and also to correlate catch-per-unit-effort with stocking rates. It is felt that increased stocking of yearlings from 50,000 to 75,000 is more in line with the need related to the present exploitation of lake trout on Lake Manitou. Some method of appraisal of the full context of Indian netting should be sought.

General Regulations

Anonymous. 1990. Trophy lake trout: Experimental Management Annual Report. Ontario Ministry of Natural Resources. Kenora, Ontario.

This Experimental Management (EMF) project seeks to maintain, if not to improve upon, the existing quality of lake trout angling in the Clearwater and Whitefish Bay areas of Lake of the Woods. Both of these basins which comprise the major lake trout waters on this lake are renowned for their trophy lake trout fishing opportunities. Lake trout in excess of 10-15 kg have regularly been taken by anglers from these areas. Long-term monitoring of angling fisheries and spawning stocks in these waters by the Lake of the Woods Fisheries Assessment Unit have shown that lake trout populations, especially older age and larger size classes of fish are rapidly being reduced by increasing angling pressure. Declines in the catch-per-unit-effort, the mean size and the age of lake trout in angling catches, and increases in number of immature fish being harvested have been observed in both areas. Also noted is a decrease in the mean size and age of spawning populations in Whitefish Bay during the same period. All evidence suggests that declines in the quality if these fisheries will continue unless regulatory measures are taken.

This project will evaluate the use of tighter harvest controls, rather than reductions in angling opportunities, to maintain/improve angling quality for trophy sized lake trout in the Clearwater and Whitefish Bays areas of Lake of the Woods. Two approaches to controlling harvest will be examined:

1. Lake trout tag (Clearwater/Cul de Sac/Echo Bay)

- All anglers will be permitted to fish but only those with a tag can harvest one fish per season.
- All fish retained must be immediately tagged.
- Tags will be drawn by lottery.
- An initial allocation of 100 tags can be increased in subsequent years.
- Anglers will be restricted to the use of single barbless hooks and artificial bait only when fishing in this area.
- No winter season – the angling season for lake trout in the Clearwater Bay

area will be open from the 3rd Saturday in May until September 30.

2. Reduced limit/maximum size (Whitefish Bay)
- One fish/day limit, two in possession.
- Only one of these fish can be over 65 cm total length.
- "single barbless hook and artificial bait only" restrictions from January 1 to the 3rd Saturday in May.

These regulations should limit or reduce overall harvest, resulting in decreased fishing mortality/increase survival and detectable changes in both the following:

1. Angling fishery:
- Overall reductions in lake trout harvest without incurring decreases in angling effort.
- Maintenance or improvement in catch-per-unit-effort (both kept and released fish).
- Increased support for and practice of catch-and-release angling for lake trout.

2. Spawning populations:
- Increased survival at all ages.
- Increased recruitment of fish to brood stock.
- Gradual increase in the number of age groups represented in spawning populations.

Bewick, P. 1985. Lake trout management in small lakes: Eastern region inland lake trout management, resources status, management direction, harvest control options. *In* 1985 Lake Trout Seminar, North Central Region. Ontario Ministry of Natural Resources. Thunder Bay, Ontario.

Lake trout management problems in the Eastern Region were identified. A lake trout classification categorization system was introduced by which lakes were selected for lake trout management.

Future management direction and regulatory options were discussed. The lake trout resource base is small relative to other inland lakes – representing less than 5% of the lakes. The lakes are very accessible and are near areas of high population density.

Three biological objectives have been developed. These are:

1. Mean age of harvest should be at least 7 years.
2. Angler harvest should not exceed allowable yield – 25%
3. Total mortality rate should not exceed 50%

Five harvest control options were developed, all of which if enacted, would result in the achievement of the biological objectives. The objectives can be summarized as follows:

1. Open season January 1-September 15. Seasonal quota of 5.

2. Open season March 10-September 8. Seasonal quota of 10 lake trout of which only 3 can be harvested in winter.
3. Open season south of Highway #7 as per #2 above. Open season north of Highway #7, March 10-September 8. Daily creel limit of 2.
4. Open season June 2- September 8. Daily creel limit of 2.
5. Open season south of Highway #7 as per #4 above. Open season north of Highway #7, March 10- September 8. Daily creel limit of 2.

Christie, W. J. 1978. A study of freshwater fishery regulation based on North American experience. Fisheries Technical Paper No. 180. Food and Agriculture Association of the United Nations. Rome, Italy. 46p.

The inland fisheries of Canada are representative of many stages of development varying with the demographic, social and economic conditions of different regions of the country. The scientific management of these fisheries has received considerable attention. Thus, an examination of management practice in Canada, both historically and in relation to these different regional characteristics, provides an opportunity to evaluate management strategy and tactics in order to improve future management wherever substantial inland fishery resources exist. Historically, management of these fisheries has been sometimes effective and sometimes not. It has also, in some cases, been misdirected and, while effective in accomplishing the goals sought, it has been inappropriate in a larger context. Thus an analysis of the problems of inland fishery management goes beyond scientific aspects. Social and economic factors as well as the status of the resource must be better appreciated if effective management is to be achieved. As the socio-economic requirements vary regionally, a zonal approach to regulations and management is recommended in spite of some inconsistencies, which result.

Hamilton, R. 1985. Lake trout in Thunder Bay: Some insights into re-establishment. *In* 1985 Lake Trout Seminar, North Central Region. Ontario Ministry of Natural Resources. Thunder Bay, Ontario.

In the sport fishery harvest of Lake Superior it was noted that the catch-per-unit-effort's (CUE) are increasing but the mean lengths and ages are dropping. The increasing CUE's are probably a result of increasing fishing skills. The major increase in number of participants in the trout derby has more than doubled the harvest and angler days.

As Zone 1, is now producing a total harvest greater than it ever did historically and the sports angling participants are increasing both in number and harvest, the time may be approaching where some of the following may have to be instituted for Zone 1.

There is no closed season on the angling fishery although the normal limit of three still applies.

- A shortened winter season may have to be considered.
- A reduction limit to two fish is an option.

Hicks, F. J. 1987. Exploitation and the status of lake trout in Algonquin Provincial Park. Algonquin Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Whitney, Ontario. 21 p.

Lakes of the Algonquin Fisheries Assessment Unit, chosen to represent typical lakes in the park as well as similar lakes in Ontario, include naturally reproducing populations of lake trout, brook trout, smallmouth bass and whitefish. Information from a number of creel surveys were compared as a set, using the indicators outlined in SPOF (Strategic Planning for Ontario Fisheries) working group paper #15 to determine the status of exploitation of lakes in the unit and to provide information to the fishery manager. The criteria include effort, yield, abundance, mortality, age at maturity as well as several growth parameters.

Hoyle, J. A. 1989. Results of an aerial creel survey on selected inland trout and splake lakes in eastern Ontario during the winter of 1989. Ontario Ministry of Natural Resources. Kemptville, Ontario. 24 p.

In eastern Ontario, heavy fishing and deterioration of habitat has stressed many inland lake trout populations. After extensive public consultation the Ontario Ministry of Natural Resources (OMNR) initiated several programs, beginning in 1985, to protect and rehabilitate the lake trout in eastern Ontario. Key components of the new lake trout management strategy include habitat protection, effective enforcement, lake trout harvest control, and diversion of fishing pressure to splake.

Candidate lakes in Divisions 9, 10 and 29 of the Ontario Fishing Regulations have been designated as lake trout or splake lakes for management purposes. New regulations which were implemented as part of the regional strategy included:

- A winter closure for lake trout on designated lake trout lakes in Divisions 9 and 10. In division 29 the lake trout season opened on the second Saturday in March and extended until September 8;
- A "split" season (first Saturday in February to third Saturday in February and second Saturday in March to November 30) for splake in Divisions 9 and 10. In Division 29 the splake season opened on the second Saturday in March and extended to November 30;
- An increase in the daily catch and possession and possession limit for splake to five fish on designated splake lakes in Divisions 9, 10 and 29;
- A reduction and standardization in the daily lake trout catch and possession limit to two fish on designated lake trout lakes in Divisions 9, 10 and 29; and
- A year round ban on the use of lake herring as bait in lake trout waters.

In February and March 1989, an aerial creel survey was carried out on 54 of the 63 lake trout and splake lakes in Divisions 9, 10 and 29 in a first attempt to assess the splake stocking program in eastern Ontario. In addition, angler interviews were conducted by OMNR staff and some angler diaries were distributed to splake fishermen (Division 10 only) in an effort to determine fishing success and harvest. Results of the aerial creel survey and angler interviews are reported here.

Johnson, B. M. and P. J. Martinez. 1995. Selecting harvest regulations for recreational fisheries: Opportunities for research/management cooperation. Fisheries 20(10) : 22-29.

The need for harvest regulations to manage sport-fisheries is widely recognized, but, regulations are not always selected and applied scientifically with an assessment of the ecological implications of manipulating harvest. Regulations directed at protecting top predator fishes, may have undesirable consequences for other fishes in the system. A strategy is developed for selecting harvest regulations that considers both direct effects of regulations on the target population and indirect effects on other trophic levels. The result is a set of regulation options that achieve angler and management goals while reducing unexpected or adverse responses within the fish community. This approach requires fishery researchers and managers to work closely together to be effective, and, thus, the regulation selection process offers an excellent opportunity for research and management cooperation.

Kerr, S. J. 1989. Lake trout management in eastern Ontario. Eastern Ontario Fisheries Update No.4. Ontario Ministry of Natural Resources. Kemptville, Ontario.

In an effort to develop a comprehensive lake trout management strategy, two series of public meetings were held throughout eastern Ontario in 1985. The key components of the new management program include habitat protection and maintenance, effective enforcement, lake trout harvest control and diversion of fishing pressure to splake.

New regulations which became effective in the winter of 1989 include:

- A winter season closure for lake trout on designated lake trout lakes in Divisions 9 and 10. In Division 29 the lake trout season will continue to open on the second Saturday in March and extend until September 8;
- A split season (first Saturday in February to third Sunday in February and second Saturday in March to November 30) for splake in Divisions 9 and 10. In Division 29 the splake season opens on the second Saturday in March and extends to November 30;
- An increase in the daily catch and possession limit for splake to five fish on designated splake lakes in Divisions 9, 10 and 29;
- A reduction and standardization in the daily lake trout catch and possession limit to two fish on designated lake trout lakes in Divisions 9, 10 and 29; and
- A year round ban on the use of lake herring as bait in lake trout waters.

Loftus, D. 1985. Lake trout fisheries in the Haliburton-Hastings area. *In* 1985 Lake Trout Seminar, North Central Region. Ontario Ministry of Natural Resources. Thunder Bay, Ontario.

A history of the lake trout fishery in the Haliburton-Hastings area was summarized. Access, exploitation, and introductions were discussed.

The lake trout creel limit was reduced from 5 fish to 3 fish in 1971, largely on the basis of work by Schumacher and Olver. A further reduction to 2 fish is being considered as a means of reducing the lake trout harvest without restricting opportunities. Also, winter closure may be restricted on selected lakes within the Algonquin region.

MacCrimmon, H. R. and E. Skobe. 1970. The fisheries of Lake Simcoe. Ontario Department of Lands and Forests, Fish and Wildlife Branch. Toronto, Ontario. 140 p.

The lake trout fishery of Lake Simcoe gradually changed from an unregulated commercial and sport fishery to an exclusive and highly regulated sport fishery. This evolution of the fishery involved principally the abolition of legal netting about the turn of the century and the end of legalized winter spearing only a little over a decade ago which finally reserved the lake trout solely for the angler.

A closed season was first imposed on the lake trout fishery in as early as 1889 when fishing was prohibited from November 1st to November 30th in order to protect the spawning lake trout. Although this closed season failed to coincide with the spawning season and was of no value, it was continued until 1918 when it was changed to the period of October 5th to November 5th which was satisfactory. However, the season was again changed to the period of October 25th to November 15th which covered only the latter part of the spawning time. In 1934, it was advanced further to October 5th with the closure ending on October 31st. The closed season reverted to October 15th-November 15th during the early 1940s. In 1946 it was shortened to a period from October 6th to November 5th. Presently the closed season extends from October 6th to December 18th.
A legal daily possession limit of 3 lake trout was imposed in 1918 but changed three years later to 5 lake trout per day. The daily limit remained unchanged for many years until the recent reduction to a possession limit of two lake trout in 1956.

The lake trout population of Lake Simcoe requires limited but definite management. The excellent habitat conditions coupled with an abundance of natural food have produced fast-growing and well-conditioned trout which are available to the competent angler. The extensive areas of fine spawning beds have maintained a substantial population of lake trout through the years even when subjected to an early commercial fishery which is known to have removed in excess of 1½ million pounds of trout. This in addition to the tremendous quantities taken by unreported angling, spearing and netting through the years.

The present day creel limit if 2 lake trout per day, representing a weight of fish adequate for the normal requirements of most fishermen, has been a matter of discussion among sportsmen. A survey has shown that the majority of people have favoured the reduction in possession limit because of its intent to prevent the possibility of overexploitation of the lake trout population by intensive angling particularly during the winter months. Although it is questionable that a reduced limit has increased significantly the angling success of the poor or mediocre fishermen, it has resulted in a more effective control over the sale of trout during the winter fishery when daily creel limits can be taken with regularity by some skilled fishermen.

A length limit on lake trout in Lake Simcoe is unnecessary and, at any rate, only larger trout are taken commonly on the selective trout baits.

The closed season on lake trout fishing between October 6th and December 18th adequately covers the period during which the trout are on the spawning grounds. Although this legislation is aimed at the protection of the trout from unethical anglers while the fish are concentrated on the shoals, the fact that it makes illegal the possession of lake trout about the lake is of particular value in curtailing illegal netting and spearing which can remove spectacular quantities of trout in a single night of fishing. The protection of the lake trout while on the spawning grounds is an important management practice but constitutes a difficult task for the small group of conservation officers who patrol Lake Simcoe. Rigid law enforcement followed by heavy penalties to violators, is necessary if illegal activities are to adequately controlled in order that the trout may reproduce naturally, and be reserved for the sport fishermen.

Macins, V. 1985. An assessment of the effects of angling pressure on lake trout in Whitefish Bay, Lake of the Woods. Lake of the Woods Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Kenora, Ontario. 17 p.

Effective angler exploitation of lake trout in Whitefish Bay and signs related to stress are discussed. Movements of marked lake trout during the period from 1954 to 1978 in relation to capture and tag sites are explored and possible measures to relieve angling stresses are considered. Migration to the outward edges of Whitefish Bay is indicated during late fall and early winter. Inward movement toward the deeper parts of the bay is evident in the spring.

Some possible options for management of lake trout in Lake of the Woods are :

- Reduced Limits and/or seasons.
- Limit or outlaw specialized gear or other methods of angling (i.e. baited dead-line angling).
- Trophy fishery only in selected lakes (areas) – reduced limits on others.
- Mixture of the above three options.
- Discriminate against non-contributors (non-resident campers).
- Lottery for a limited number of non-resident tags per tourist camp and a set number of tags (stamps) per resident per year (5 for trophy lakes and 10 for other lakes – no more than two at any one trip).

If we are serious about reducing fishing pressure on lake trout, we have to take drastic and effective action, not just cosmetic measures, to preserve this unique species.

Maher, T. 1985. Management options for small lake trout lakes in the Atikokan District. *In* 1985 Lake Trout Seminar, North Central Region. Ontario Ministry of Natural Resources. Thunder Bay, Ontario.

Atikokan District is approximately 11,000 square kilometres in area, 40% of which consists of Quetico Provincial Park. There is no intensive management

planned for the Park; the ban on powerboats and snowmachines has reduced fishing pressure to a non-critical level.

Data such as morphoeadaphic index values, relative yield index values, mean observed catch-per-unit-effort, annual mortality, age of maturity, growth and provincial growth standards and indices, are presented and discussed.

Examination of data in the context of SPOF (Strategic Planning for Ontario Fisheries) working group paper #15 defines the general status of lake trout and brook trout lakes of the Algonquin FAU. These status determinations will assist fisheries managers in evaluating other lakes, provide information for modelling these fish communities and is the first step in developing syntheses for these type lakes. On the basis of the various criteria, Smoke Lake appears to be exploited at or above the maximum for long-term sustained yield.

Martin, N. V. 1966. The significance of food habits in the biology, exploitation, and management of Algonquin Park, Ontario, lake trout. Transactions of the American Fisheries Society 95(4) : 415-422.

Algonquin Park lake trout may be piscivorous or planktivorous dependent on available food supply in the summer months. Plankton-feeding lake trout grow more slowly, do not reach as great a size or age as fish feeders, and mature at a smaller size and younger age. Trout transferred from a plankton-feeding to a fish-feeding population grow at a faster rate and extend their life-span.

Fisheries in planktivorous populations return larger numbers of smaller and younger fish to the angler. A higher percentage of mature fish occurs in these fisheries. The catch is dependent on fewer year classes and year-class strength is more variable. Yield in numbers-per-acre is higher in plankton-feeding populations but is comparable with fish-feeding populations in terms of pounds per acre.

There are no size limits in Algonquin Park at present for lake trout. The present study emphasizes the impracticality of such regulations for this species. Size at first maturity has been shown to range from 11 to 19 inches in Algonquin Park lake trout. A minimum size to protect the faster growing fish would result in many fisheries being almost entirely unavailable to the angler. The present system of non-restrictive size limits would therefore appear desirable.

Plankton feeding lake trout populations return large numbers of small lake trout to the angler. The present daily limit of three trout permits the fishermen in Lake Louisa, for example, to keep on the average slightly over 3 pounds of fish. In Lake Opeongo, on the other hand this limit allows a catch of over 10 pounds of trout. As has been indicated, yields in terms of pounds per acre are generally comparable for both types of lakes. The inequitable nature of present regulations in utlilization of the crop is therefore apparent. The catch limit system presently in force is no doubt the most practicable from the point of view of administration. However, the use of total inches or total weight regulation is worthy of consideration.

Quota systems for Algonquin Park lake trout fisheries would be difficult to administer because of the variability in the lake trout populations. Optimum use of the crop is particularly desirable in plankton-feeding populations where fisheries are largely dependent on one or two year classes, the lake trout have a relatively short life-span, and year-class strength is extremely uneven. The causes of these fluctuations are not yet understood and predictions of future abundance of lake trout as a basis for setting up quotas are not yet possible.

Two lake closure practices have been carried out in Algonquin Park lakes. The first of these has been a systematic lake closure program, designed basically to increase spawning escapement. In Lake Opeongo, where no closure is in effect, a positive correlation exists between spawning escapement and year-class strength.

The apparent contradiction may be explained on the basis of the differences in the character of the two populations. In lakes such as Happy Isle and Merchants, which have planktivorous trout, rate of growth is slower and recruitment to the spawning stock in the closed years would be at a reduced rate. Second, year-class strength is naturally more variable in lakes such as these. This may serve to mask possible beneficial effects of increasing size of spawning stock or indicate environmental pressures are more important than the number of spawners as factors of year-class strength. The evidence to date therefore suggests lake closure programs may be most beneficial to intensively fished lakes with faster-growing trout and more stable year-class production.

The second type of closure that has been practised in Algonquin Park lakes has been that of winter fishing. These fisheries result in larger catches and greater exploitation of small fish in many lakes than is the case with summer fisheries. This is particularly evident for those small lakes supporting slow-growing, plankton-feeding trout. In these lakes productive fishing areas are more easily localized and catches in winter often exceed those in the open-water months. Summer fishing with wire line and heavy spoons serves as a self-regulatory control on the size of fish caught and spawning escapement is high. Winter fishing with set lines and live bait exploits a much higher percentage of small and immature lake trout. The faster growing trout particularly in the larger lakes were not as vulnerable to winter fisheries either in harvest rates or in the utilization of small trout. Present evidence therefore indicates closure to winter angling may be most beneficial to the plankton-feeding populations.

The introduction of the cisco as a forage species to Lake Opeongo has resulted in faster-growing, better-conditioned lake trout and would likely achieve the same result in plankton feeding populations. However, such a measure would destroy the high spawning escapement currently enjoyed by these populations, although as has been previously pointed out, size of spawning stock may not be an important factor in year-class strength. The higher availability of trout in plankton-feeding populations and their superior table qualities make them desirable to many anglers and they should be preserved.

McKnight, T. C. 1977. Investigations of lake trout and whitefish in Trout Lake, Vilas County, Wisconsin. Fish Management Report No. 98. Wisconsin Department of Natural Resources. Madison, Wisconsin. 18 p.

During the past 20 years (1956-1976), marked lake trout (*Salvelinus namaycush*) have been stocked periodically in Trout Lake. The purpose of this report is to evaluate these stockings and subsequent recoveries in fall netting and winter angling, and provide a record of past management and investigative efforts. Catches of whitefish (*Coregonus clupeaformis*), another cold water sport fish in Trout Lake, are also analyzed. Recommendations for future management and investigations of lake trout and whitefish in Trout Lake are provided at the end of this report.

Prior to 1953, fishing seasons for lake trout opened on April 1 and closed on September 30. The first winter fishing season opened January 1 each year. Since 1967, the season opened on the first Saturday of January. The September 30 closing remained constant. Prior to 1957, the daily bag limit was 5 lake trout and the size limit was 17 inches. Since 1957, the bag limit has been 2 fish. The size limit remained at 17 inches.

Milliman, S. R., A. P. Grima and C. J. Walters. 1987. Policy making within an adaptive management framework, with an application to lake trout (*Salvelinus namaycush*) management. Canadian Journal of Fisheries and Aquatic Sciences 44(2) : 425-430.

Using lake trout (*Salvelinus namaycush*) rehabilitation in the Laurentian Great Lakes as an example, we combine policy design process known as “adaptive management” in biological circles with basic concepts found in natural resource economics. Emerging from this synthesis of biological and economic thought is a practical method for making policy choice in fisheries in the presence of biological uncertainty. We introduce this method by first reviewing key biotic uncertainties, which impede the process of lake trout rehabilitation. Drawing upon these uncertainties a framework is proposed for developing a set of policy options. Included in these options are “actively adaptive” policies which are purposely experimental in hopes of both reviving the lake trout fishery and concurrently yielding data which may alleviate the nagging uncertainties. Using basic concepts from natural resource economics, we then, outline how, in the presence of key uncertainties, the policy which most likely maximizes socio-economic gains can be chosen from the various options. We conclude with some brief policy implications for lake trout rehabilitation.

Noble, R. L. and T. W. Jones. 1993. Managing fisheries with regulations. p. 383-402 *In* C. C. Kohler and W. A. Hubert [eds.]. Inland Fisheries Management in North America. American Fisheries Society. Bethesda, Maryland.

Successful fisheries management must incorporate the use of appropriate and effective regulations along with other management tools to meet defined management objectives. Regulations are tools to be used in conjunction with other management practices such as population and habitat manipulation. The ability to use regulations effectively depends upon an understanding of fish

population dynamics and how the population can be expected to respond under the existing habitat conditions.

Minimum size limits, which prohibit the harvest of fish below some specified length, are generally imposed to lower both angling and total mortality in highly vulnerable populations and to reduce exploitation of fish before they reach sexual maturity. Historically, minimum size limits were implemented to prevent overharvest and depletion of fish stocks and were frequently set to protect juvenile fish until maturity.

Maximum size limits are rare, but in situations with relatively few sexually mature adults or where large numbers of smaller fish exist and the manager intends to increase growth rates, maximum size limits can be beneficial.

Slot limits prohibit harvest from a designated intermediate size range. Harvest below the slot may take advantage of a surplus of recruits and allow additional energy to be channelled into mid-sized fish, which then survive and grow out of the protected range and into the harvestable range.

Creel limits are usually defined as the allowable fish, either in number or weight, that can be harvested during a particular time period. Creel limits are instituted so that harvest may be more equitably divided; they also have sociological value since they give the angler a specific target and the satisfaction of catching a limit. Daily creel limits have a high degree of voluntary compliance and are easily enforced.

The ideal catch regulation is one that controls total harvest by fish size group based upon knowledge of the population dynamics of the target species. Such a regulation is termed a quota, which is typically applied on an annual basis. After the established annual quota has been harvested, the fishery for that species is closed to further harvest. Unfortunately, most agencies do not possess the necessary personnel to collect up-to-date harvest information from which to determine when a quota is reached.

Although many underexploited fisheries are managed with continuous open seasons, many agencies close seasons during peak spawning activities to protect spawning fish. Seasons are sometimes also established for the safety of users.

Areas are sometimes closed to fishing to protect or enhance the resource or to protect the user. The seasonal closure of areas to protect certain species brings up the question of whether anglers who fish for other species should be denied access. Closure of areas may be necessary as fish populations are initially established or are re-established following reclamation.

Restrictions on gear are imposed to promote a diversity of fishing experiences and inefficiency of harvest. Gear restrictions are also applicable when a large number of fish are to be released after capture such as when size limit or catch-and-release regulations apply. Gear restrictions, unless used to decrease mortality, should only be considered to meet social, as opposed to biological, objectives.

Olver, C. H. 1988. The regulation of harvest in lake trout sport fisheries: A review and appraisal. Ontario Ministry of Natural Resources. Toronto, Ontario. 67 p.

The paper provides the basis for development of a general harvest control strategy for lake trout in Ontario. It reviews the regulations used to control exploitation of lake trout, assess their effectiveness and proposes direction for harvest control. In Lac La Ronge, Saskatchewan a potential conflict between anglers and commercial fishermen was averted before it became a contentious issue by increasing the catch of lake whitefish (*Coregonus clupeaformis*) and reducing the harvest of lake trout in the commercial fishery. Reductions in the commercial lake trout quota were also proposed for Cree Lake, Saskatchewan to accommodate the rapidly expanding sport fishery. Commercial fisheries for lake trout have also been closed in order to protect the sport fishery. For example, commercial over exploitation of lake trout at Great Slave Lake, Northwest Territories resulted in their virtual elimination from the western end of the lake. As this process appeared to be progressing eastward, it was recommended that the commercial fishery in the eastern end of the lake should be closed to protect the sport fishery.

In Ontario, commercial fishing for lake trout is permitted in only 19 lakes and 98.4% of the total commercial lake trout quota in the 2.1 to 7.5% of the total quota in these lakes is comprised of lake trout. The other 16 lakes are in northwestern Ontario and, with one exception, the primary commercial species is lake whitefish. Only a small portion (0.1 – 8.2%) of the total quota in these lakes is allotted to lake trout. Lake trout quotas in these lakes vary between 35 and 1.818 kg yr $^{-1}$ and in seven of the lakes the annual quota for lake trout is than 100 kg.

As effort is the primary determinant of lake trout catch, restricting the length of open seasons is still the most effective means of controlling effort and thereby catch. Seasonal restrictions may have particular relevance to winter fishing as biologically, its effects on lake trout stocks are potentially more damaging. Access controls may also be used to reduce effort, but a more complete understanding of their role as a fisheries management technique is required. Harvest may also be controlled by means such as size limits, catch limits, quotas and gear restrictions.

Following is a set of recommendations suggesting some areas of regulatory control which might be undertaken:

- Review the existing array of seasons, including sanctuaries and consolidate where possible.
- Develop further the relation between yield and lake surface area for use as a possible regulatory mechanism.
- In areas where exploitation during the winter and/or early spring is severe, adjust the length of the open season by either delaying the usual opening date of January 1, or creating a split season by closing it before the ice goes out and reopening it sometime after the ice is out.

- Promote the use of effective procedures for hook removal, handling and release of fish through a public education program.
- Continue studies, such as Lake Opeongo, which evaluate the use and effectiveness of high technology gear.
- Evaluate the role of access restrictions as harvest control mechanisms.

Olver, C. H., R. L. Desjardine, C. I. Goddard, M. J. Powell, H. J. Rietveld and P. D. Waring. 1991. Lake trout in Ontario: Management strategies. Lake Trout Synthesis Working Group. Ontario Ministry of Natural Resources. Toronto, Ontario. 88 p.

The lake trout is a sensitive species because of: its ecological requirements – the rigorous constraints imposed by the cold unproductive ecosystems it inhabits; its vulnerability to all forms of human imposed stressors; and its inability to adapt to and cope with rapidly changing environmental conditions. These conditions assure that it can only exist in a small number of lakes throughout the world. It is susceptible to population collapse and extinction – a situation compounded by the fact that population loss may occur subtly and over a matter of decades. This slow process of attrition tends to defuse any sense of urgency to take strong corrective measures. Irrespective of the cause of extinction, it is not just fisheries that are threatened. Genetic diversity of reduced and unique gene pools may be lost forever.

The message is clear. Strong measures are needed to ensure healthy, self-sustaining populations of lake trout. Only through a conservation-oriented strategy can the people of Ontario continue to derive social and economic benefits from the lake trout resource. Our strategy recognizes the limited nature of the resource, the need for strict controls and the necessity of an ecosystem approach to management. The emphasis should be on public understanding and acceptance of a management regime centred on the provision of high quality environments and low annual yields sustained by natural reproduction.

Although the focus of this report is the lake trout, the report has broad application for the management of aquatic ecosystems and other types of fish communities and fish species in general.

Olver, C. H., D. Nadeau and H. Fournier. In press. The control of harvest in lake trout sport fisheries on precambrian shield lakes. *In* J. Gunn, R. Steedman and R. Ryder [eds.] Boreal shield watersheds: Lake trout ecosystems in a changing environment.

Despite increasingly comprehensive and complex legislation intended to regulate exploitation, it is the most critical stress affecting the lake trout (*Salvelinus namaycush*) across the precambrian shield. The two main contributing factors are the lake trout's innate vulnerability to exploitation and the rapid growth of recreational fishing following the end of the Second World War. For instance, angling almost quadrupled in Ontario between 1950 and the early 1970s (Ontario Ministry of Natural Resources and Environment Canada 1976). With the development and expansion of highways and forest access roads, the advent of

the snow machine and the all-terrain vehicle, and the ready availability of aircraft, few lake trout lakes are inaccessible to anglers.

Recommendations

The first set of recommendations suggest some areas of regulatory control which might be implemented or reviewed now. They are:

- Use the harvest equation presented in Payne et al. (1990, $\log_{10}\text{Harvest} = 0.500 + 0.830\log_{10}\text{Area}$, where Harvest is kg/(ha·yr) and Area is ha) and the age-structured model developed by Shuter et al. (1998) to determine sustainable levels of harvest, fishing effort, and fishing mortality to determine whether new harvest control regulations need to be implemented.
- Use the age-structured LTMSS (Korver 1992) and FMSS (Korver and Kuc in prep.) models to test and evaluate effects of proposed changes in effort, size limits or daily catch limits, or to determine the most appropriate changes.
- In areas where exploitation during the winter and/or early spring is intense, adjust the length of the open season by either delaying the usual opening date of January 1, or creating a split season by closing it before the ice goes out and reopening it sometime after the ice is out.
- Review the role of access restrictions as harvest control mechanisms.
- Review/consider regulations that prohibit culling of fish.
- Review/consider regulations that reduce daily catch limits by means of a conservation licence.
- Review/consider regulations that prohibit or restrict the use of set lines when fishing through the ice.

The second set of recommendations suggest some areas of regulatory control that should be initiated under a program of experimental management in which fisheries projects are treated as hypothesis-testing experiments. Casual observations drawn from creel surveys seldom provide the data necessary to make informed judgements about the effects of regulatory changes. It also takes many years to accumulate data. Experimental management, however, "with appropriate control lakes, can accelerate the process significantly" (Ontario Ministry of Natural Resources 1978b). Lakes selected for study require pre-experimental data on the fishery and the population to which the impacts of changes in regulations can be compared. Experimental management projects should be limited, at least initially, to testing one variable at a time. This will avoid the problem of confounding variables whereby two or more techniques are applied or changed at the same time, such that the contribution of each cannot be determined. Tests using multiple tactics should only be conducted after the effects of each single variable have been independently evaluated.

Experimental management programs should be designed to evaluate:

- Hooking mortality of lake trout caught during the period of ice cover.
- Hook size as a possible mortality factor.
- The practice of allowing only one fish of the daily catch limit above a specified size to be kept as a means of controlling the harvest of large fish.
- Maximum size limits.

- Slot-size limits.
- Total or cumulative daily length or weight limits in place of daily catch limits.
- Seasonal or annual catch quotas for the individual angler - lake specific or jurisdiction wide.
- Seasonal or annual catch quotas for specific lakes, or parts thereof.
- Reduced daily catch limits during the period of ice cover.
- Effectiveness of a one line restriction during the period of ice cover.
- Effect of party size on angler catch rates.
- Difference (if any) between catch-per-unit-effort using live and dead bait fish.
- A ban on the use of bait fish (alive and dead).
- A ban on large bait fish (alive and dead) in lakes where anglers use this method to target on large lake trout.
- Use and effectiveness of high technology gear.

Ontario Ministry of Natural Resources. 1982. Control of angler overexploitation. Report of the Strategic Planning for Ontario Fisheries Working Group Number 16. Toronto, Ontario. 68 p.

The control of angler harvest in Ontario until the 1960s consisted primarily of passive, indirect regulation which was well-suited to the relatively abundant resources and low angling demand during that period.

However, beginning in the mid-1960s, as a demand began to exceed supply, managers attempted regulatory counter-measures that were often too little, too late. The traditional tools available to them were often inappropriate and ineffective.

As a result, fish stocks have been more often subjected to excessive exploitation, and attempts to control harvests with traditional, but often out-moded measures, have often been met by resistance from users.

Angler harvest control in the 1980s and beyond must allow for the maintenance and re-building of fish stocks while at the same time providing more recreational opportunities.

The summary of the Working Group's recommendations are as follows:

1. Modernize angling regulations so that they become more effective in controlling exploitation while simultaneously providing optimal recreational opportunities.

    - Establish an advisory group to contribute to the modernization exercise, made up of OMNR field and main office staff and perhaps selected members of the public with requisite interest in and knowledge of angling.
    - Liberalize regulations and deregulate whenever possible and consider non-regulatory alternatives whenever possible.
    - Base all regulations on sound rationale.
    - Test, evaluate and update old and new techniques in a rigorous, coordinated fashion on an ongoing basis.

2. Institute a resident angling licence with provisions for additional user-pays and harvest control options such as species stamps and annual creel limits for certain species.

3. Promote under-utilized species and encourage alternate angling opportunities.

4. Explicitly recognize and foster a new angling ethic in which the quality of the angling experience becomes more prominent than the numbers of fish creeled.

5. The Ministry of Natural Resources investigate new ways of limiting angler access and make more widespread use of existing potential controls.

Ontario Ministry of Natural Resources. 1995. Management plan for naturally reproducing populations of brook trout and lake trout in south central Ontario. Brook Trout/Lake Trout Management Committee. Toronto, Ontario. 32 p.

On a province wide basis, exploitation has been identified as the most critical stress affecting lake trout in Ontario. Locally, exploitation has been identified as a problem in South Central Ontario that must be addressed. New management actions are required to bring lake trout harvests to sustainable levels. A slot size limit, a minimum size limit followed by a slot limit and a winter/early spring closure were proposed to the public to attain a sustainable harvest. A restriction on the use of live baitfish during the winter months would accompany the size limits.

Public opinion was more or less evenly split between the choice of a winter/early spring closure and size limit restrictions. As a result, to ensure the sustainability of naturally reproducing lake trout populations, the following harvest restrictions will be employed:

- Lakes less than 100 hectares (250 acres) and lakes with small-bodied lake trout populations will have an open lakes trout season from the third Saturday in May until September 30th (September 8th for Division 29); and lakes greater that 100 hectares (250 acres) which have large-bodied lake trout populations will have a slot size limit (40 cm to 55 cm or 16 inches to 22 inches total length) imposed in addition to existing seasons. Anglers will be required to release fish caught within the slot size.

This strategy combines elements of the slot size limit and winter/early spring closure season options. This combination strategy best echoes the public response and comes closer to lake specific management than any of the harvest options individually.

To minimize the mortality of released lake trout in lakes where slot size limits will be implemented, the following regulations will also be implemented:

- The slot limit will be accompanied by a one line only restriction and a ban on live baitfish during the winter fishing season (i.e., through the ice).

New science has demonstrated that supplemental stocking of lakes that have naturally reproducing populations is detrimental to the natural population. To ensure the survival of naturally reproducing lake trout populations:

- Supplemental stocking into lakes which can sustain naturally reproducing populations of lake trout will be discontinued.
- Stocking is permitted in lakes which have no natural reproduction or for which reproductive status is undetermined.
- Stocking is permitted to rehabilitate lakes in which the native stock has become extinct, or to extend the range of lake trout.

Ontario Ministry of Natural Resources. 1988. Clearwater Bay lake trout strategy. Ontario Ministry of Natural Resources. Kenora, Ontario. 8 p.

Ontario Ministry of Natural Resources and Ontario Ministry of the Environment. 1993. Inland lake trout management in Southeastern Ontario. Kemptville, Ontario. 160 p.

Southeastern Ontario has the southern most representation of inland lake trout lakes in Canada. Lake trout require cold, deep, well-oxygenated water for survival. Suitable lakes are finite and have been dwindling from the time of settlement due to several major factors that have acted singly or in combination to eliminate lake trout habitat. The subsequent disappearance of native stocks began in the early 1900's and has continued at an accelerated rate until the present.

In 1975, the two ministries initiated a lakes survey program intended to assist landuse planners and resource managers in assessing the potential water quality and fisheries implications of shoreline development proposals.

This report summarizes the original findings and reflects the more recent work on water quality and fisheries management. It recommends actions with respect to land use and development which will contribute to long-term water quality and fisheries management objectives for the lake trout waters of southeastern Ontario. It also will complement the implementation of approved district fisheries management plans.

Ontario Ministry of Natural Resources. 1999. Discussion paper: On regulation proposals for "natural" lake trout lakes in the Parry Sound area. Parry Sound, Ontario. 15 p.

This discussion paper is intended to introduce the angling public to fishing regulation proposals being put forward by the Parry Sound Area of the Ministry of Natural Resources and to solicit public opinion on those proposals. Proposals pertain to lakes presently assessed as naturally reproducing lake trout lakes. This paper does not deal with stocked lake trout lakes that are currently being managed as artificial, put-grow-take (PGT) fisheries.

The above lakes have been divided into four groups dependent on the management objective for each. Regulation recommendations are provided for each group of lakes.

1. Lakes to be managed for high quality (catch-per-unit-effort), remote fishery. This group of lakes includes Miskokway Lake and Trout Lake. Recommended regulations for these lakes are:

   - Open season: 2 weeks in winter (Feb. 14th- last day in Feb.); open-water season: 3rd Saturday in May- Sept. 30th;
   - Catch limit of 2 lake trout; 1 for Conservation Licence holders;
   - One line only for winter fishery; and
   - Protected slot size of 40-55 cm total length (fish within the slot size are released).

2. Lakes requiring rehabilitation to productive recreational harvest fisheries. Lakes in this category include Wahwashkesh Lake (McKenzie Twp.), Sollman (a.k.a. Horn) Lake (Chapman Twp.), Three Legged Lake (Foley Twp.) and Flaxman Lake (Christie Twp.). Recommended regulations are:

   - Open season: 3rd Sat. in May- Sept. 30th (i.e. winter closure);
   - Protected slot size: 40-55 cm total length (fish within the slot are released);
   - Catch limit of 2 lake trout; 1 for Conservation Licence holders;
   - (Winter fishing for alternate species permitted as per regular seasons and catch limits for those species); and
   - Single line for winter fishing (to minimize hooking mortality associated with incidentally caught lake trout).

3. Lakes to be managed as recreational harvest fisheries. Spider Lake is the only lake in this group. Recommendations for this lake are:

   - Open season: Jan. 1st- Sept. 30th;
   - Catch limit of 2 lake trout; 1 for Conservation Licence holders;
   - One line only for winter angling; and
   - Protected slot size of 40-55 cm total length.

4. Lakes to be converted to artificial, put-grow-take (PGT) fisheries. Lakes in this group include Otter Lake (Foley Twp.) and Star Lake (Christie Twp.). Regulation recommendations for these lakes include:

   - Open season (year round excluding Dec. 24th);
   - Catch limit of 2 lake trout; 1 for Conservation Licence holders;
   - No size restrictions; and
   - Two lines permitted for winter fishery.

   In recent years, the Southcentral Region of the Ministry of Natural Resources has made a concerted effort to standardize and rationalize lake trout

regulations for various categories of lake trout lakes. The suite of regulation options adopted for controlling harvest on lake trout lakes includes: winter closures; a 40-55 cm protected slot size (for large lake trout populations – which we have); catch limit of 2 with Conservation Licence limit of 1; and single line for winter fishing. We have selected a mix of these options in recommending appropriate regulations for each group of lakes. Only on the "exceptional lakes" of Miskokway and Trout have we deviated by making recommendations outside of these standard options.

Admittedly, standardizing regulation options imposes considerable limitations on the recommendations of the Parry Sound Office as well as those of the public. Deviations from the above options will only be entertained by our Ministry where it can be soundly rationalized that they are necessary to meet the management objective for any particular lake. We ask the public to bear this in mind when responding to the questionnaire.

Plosila, D. S. 1977. Lake trout management program for New York State. New York Department of Environmental Conservation. Albany, New York. 68 p.

In considering New York's lake trout sport fishing regulations, it is well to bear in mind that optimum statewide angling regulations are designed to provide a level of angling opportunity and success that is satisfactory to fishermen, while at the same time afford a safety margin for protection of the resource. Specific regulations may apply to waters where conditions permit more liberalized or warrant more stringent controls. However, regulatory simplicity that can be readily understood by the angler is desirable and accordingly, special fishing regulations should be kept at a minimum number to avoid regulatory complexity, variety and confusion. A summary of general and additional regulations is listed below as they pertain to existing lake trout waters (81 inland lakes, 3 border lakes). Lake trout waters not open to public fishing are excluded from this inventory.

The existing general statewide fishing season (April 1- Sept. 30) for salmonids and coregonids (whitefish) was established to protect fall spawning species during their particularly vulnerable spawning period and to avoid excessive harvest over winter. Lake trout in New York spawn from late September to early December and seem to be adequately protected in most instances by the September 30 closure. This basic six-month open season applies to 44 inland lake trout lakes and more conservative modifications apply to four other lakes. Extensions of the general season after September 30 (10 lakes), closure only during October (1 lake), and year-round fishing (22 lakes and 3 border lakes) provide additional lake trout fishing opportunity often in conjunction with one or more other salmonids (rainbow trout, salmon, splake). Providing these longer fishing seasons does not lead to excessive harvest of self-sustaining lake trout populations, the added angling satisfaction they generate is justifiable. Accordingly, lake trout populations exposed to angling during the fall and/or providing more than six months of fishing per year must be considered lake by lake to determine that these more liberal fishing seasons are not excessively damaging to the lake trout resource.

Lake trout of any size can be kept in Lakes Erie and Ontario. The majority of New York's lake trout waters (75 inland lakes and Lake Champlain) require a lake trout to be at least 15 inches long to be legal for possession. Although several lakes with extremely slow growing lake trout have been able to maintain their populations with 12 inch minimum size limits, and more recently regional fisheries biologists expressed concern that lake trout reproduction in some New York lakes may not be sufficiently protected by the present general minimum size. The statewide 15 inch minimum size limit has been in effect since at least 1902. In the past it may have provided for adequate escapement of sub-adult lake trout to maintain both a fishery and spawning populations with a wide margin of safety. However, lake trout maturity is age-dependent and relatively fast growing fish may not become sexually mature until considerably larger than 15 inches. Former conditions (more lake trout, larger average size, less fishing pressure) may have been more conducive for voluntary release of sub-adult lake trout and/or lower probability of capture before, which provided fish with the opportunity to spawn one or more times. Today the dedicated lake trout angler has access to sophisticated fishing gear, which can or may have resulted in a substantial increase in angling efficiency and thus the total harvest. Accordingly, in four inland lakes 20 and 21 inch minimum size limits have recently been put into effect to offer added protection to natural reproducing populations. Future investigations and evaluations of lake trout size-maturity relationships and angling catches in other lake trout waters may also necessitate increasing their minimum legal size limits for lake trout. The alternative of no regulatory changes in minimum size limits can lead to a poor quality of fishing and to decreased natural recruitment along with increased dependency upon hatchery-reared fish to maintain a lake trout fishery, resulting in unnecessary increases in management costs.

Seventy-three inland lake trout waters and Lake Champlain have a three lake trout daily creel limit. In Lakes Erie and Ontario the daily creel limit includes five lake trout in aggregate with trout and salmon. Although the lake trout limit is probably infrequently achieved and hence not excessively liberal, there are specific conditions where a lower creel limit is desirable. Regulations in four inland lakes allow a daily take of three lake trout in aggregate with other trout (3 lakes) or with Atlantic salmon (1 lake). Regulations in four other inland lakes allow only one lake trout to be taken per day.

The statewide fishing gear regulation is a maximum of two lines limited to 15 hook points each. These regulations are in effect for all lake trout waters. Protective measures for two inland lakes further stipulate that only artificial lures may be used to take fish from these comparatively small, self-sustaining populations. Excessive harvests of juvenile (sub-legal) mortality of lake trout through intensified use of sophisticated fishing gear, including downriggers, trolling speed indicators, water temperature thermometers and recording type depth sounders may require reduced daily limits and/or gear restrictions in additional lakes. Efficiency and usage of this type of gear and its effects on the lake trout resource should be investigated and evaluated, particularly in waters where declining or extremely sparse lake trout populations are found.

Ice fishing for lake trout is permitted in 24 inland lake trout lakes and in all 3 border lakes. Two lines or five tip-ups are permitted in inland waters, while 2

lines or 15 tip-ups are permitted on border waters. Lake trout may not be taken by ice fishing on 54 inland lakes trout lakes, but ice fishing for other species is permitted on some of these waters. Lake trout may be highly vulnerable to ice fishing in some lakes and less frequently caught in other lakes. Populations in some large lakes may be sufficiently large to provide at least a modest winter angling harvest without serious damage to the resource. However, each ice fishery must again be considered and evaluated on a lake-by-lake basis. Recent investigations in 28,000 acre Lake George revealed that ice fishermen harvested an estimated 1,000-1,500 juvenile lake trout from a relatively small area during the winter of 1973-74. Subsequently, an area of about three square miles in Lake George was designated a lake trout nursery or sanctuary area closed to ice fishing. This regulatory action was desirable as the Lake George lake trout population is still rebuilding following its previous decline. Full development of its reproductive potential is desirable as well as providing larger-sized lake trout for the fishery.

In summary, it is evident that New York's lake trout fishing regulations need review on both an individual water and statewide basis. Length of season, minimum size, daily catch limits, gear and ice fishing must be considered in the light of their effectiveness, complexity and variation. Lake trout regulatory goals are to:

1. Protect the resource and perpetuate it for future generations of anglers and others.
2. Permit reasonable harvests.
3. Make regulations as simple and easy as possible for anglers to understand. and
4. Strive for regulatory uniformity with a balance between resource and social needs.

Reid, D. M., D. M. Anderson and B. A. Henderson. 2001. Restoration of lake trout in Parry Sound, Lake Huron. North American Journal of Fisheries Management 21 : 156-169.

The purpose of this study was to explain how a series of management actions facilitated the restoration of lake trout (*Salvelinus namaycush*) in Parry Sound of Lake Huron. Since 1988, the relative abundance of wild spawning lake trout has increased in Parry Sound. Estimates of the spawning population (1994-1997) varied between 16,000 and 29,000 individuals. This increase in abundance was achieved by controlling sea lamprey (*Petromyzon marinus*) (1960), stocking yearling lake trout derived from the remnant stock (1981-1997), creating a refuge (1987), restricting harvest by reducing both angling seasons and possession limits (1981), and imposing a size limit for retention (1994). By 1997, the three criteria of successful restoration were achieved, that is the average age of mature females was 1 year older than the age of first maturation, wild fish composed 50% of the spawners, and the abundance of wild lake trout had been stable or increased for three consecutive years. As a consequence, stocking of yearlings was discontinued after 1997. A stochastic simulation model was developed to assess the likelihood of realizing sustainable harvest over a range of total mortality rates. We concluded that lake trout restoration is possible if sea lampreys are controlled, the appropriate strain in stocked, and exploitation is

restricted, although additional limiting factors could hinder rehabilitation success in some locations of the Great Lakes.

Roche, K. 1985. Summary of lake trout creel surveys in northwestern and northcentral Ontario: Yield related to effort estimates. *In* 1985 Lake Trout Seminar, North Central Region. Ontario Ministry of Natural Resources. Thunder Bay, Ontario.

There are a number of management options that have the potential to reach the Ministry of Natural Resources lake trout objective. The first part of this objective is to maintain, protect, and enhance lake trout populations, and the second is to provide recreational angling opportunities to the general public, based on an optimum sustainable yield.

One management option is the null alternative (do nothing). As trout lakes are discovered and accessed in the Sedwick area, they will be fished up. Trout populations will become degraded but not likely extinct. In terms of the available District supply of lake trout, we are talking about a drop in the bucket. We don't feel that the null alternative will accomplish the objective.

Another option is gating the road. We dislike this option for several reasons. Overharvesting due to access by snow machine and aircraft would still occur, therefore, gating would merely discriminate against the less affluent anglers. Gates are also a pain in the butt. They prevent access by hunters and berry pickers, and people are always getting locked behind them.

Reducing harvest by reducing seasons is another management option. Essentially, this would involve more partial sanctuaries. It would help "protect lake trout populations" but would reduce the angling opportunities available. However, if overharvesting can happen in an hour, a two month season would not offer a great deal of protection. Also, focusing attention on the area could result in a "land office stampede" situation, actually increasing annual pressure and harvest.

Reducing the daily catch limit to one fish is a management option that could provide a good compromise between protecting the resource and providing fishing opportunities. In order to implement a reduction in daily catch the lakes and/or area involved would have to be identified, with the exclusion of lakes that do not (at this time) need protection. Public consultation would be necessary for a limit reduction as some of the larger lakes in this area have cottages and outpost camps, whose owners would probably object to the reduced limit due to the lack of other sport species.

Stocking brook trout in the area is another option that would serve to divert attention from lake trout. Based on past experience, these would probably be "put-and-take" fisheries. This option would not, of itself, afford the required amount of protection to the lake trout, but it would certainly be a beneficial additional tactic. One potential problem is the possibility of damaging existing lake trout populations in stocked lakes. This danger is probably slight, and could be avoided by stocking only water bodies without lake trout (if we can find any).

Smith, P. 1988. Regulatory strategy for Ontario lake trout. Lake Trout Regulatory Strategy Committee. Fisheries Branch Ontario Ministry of Natural Resources. Toronto, Ontario. 30 p.

There is no panacea – no single, universally applicable regulatory option that by itself will rectify concerns about overexploitation. Streamlining of regulations over large geographical areas is desirable both to simplify the regulations and to establish a common base from which lake-specific management tactics (as necessary) can be established. A variety of regulatory techniques are required to manage the sensitive lake trout resource and to satisfy a wide range of biological, geographical, socio-economic and administrative circumstances.

The committee recognizes the need to address the overall management of lake trout on a broad basis. The development of a provincial lake trout management strategy dealing with habitat protection and rehabilitation, culture and stocking, etc. (and incorporating the work of this harvest control committee), is recommended.

Note – There are a number of specific regulations dealt with in this report that have not been summarized in this abstract.

Webster, D. A., W. G. Bentley and J. P. Galligan. 1959. Management of the lake trout fishery of Cayuga Lake, New York, with special reference to the role of hatchery fish. Memoir 357. Cornell University, New York State College of Agriculture. Ithaca, New York. 83 p.

It is apparent that there is no justification for increased stocking under present conditions. Rather, the problem centres on means for attaining greater utilization of existing stocks. This is directly related to the amount of fishing and regulations restricting the fishery.

Legal restrictions on the catch of lake trout in the Finger Lakes comprise a limit of 3 fish per day, a minimum size of 15 inches, and an open season from April 1st through September 10th. For the most part, the minimum size is without restrictive function in Cayuga Lake and probably in all lakes containing alewives. This is partly the result of selection on the part of the angler, and partly because usually few small trout are taken. It is evident that reduction or removal of size restriction would accomplish little to no increase utilization.

The three fish limit is restrictive, however, during the midspring angling, when lake trout are most vulnerable and effort is at a maximum. A seasonal average of 18 percent of the trips resulted in limit catches of trout, with the high points in May and June (23 percent each month). While increasing the bag limit would increase the catch (mostly for a group of skilled anglers), this is not a reasonable move in a sport fishery where the average size of the trout is 3½ pounds. Increased utilization should be aimed at maintaining maximum distribution of the catch over a period of time.

The length of time during which trout may be taken is the only restrictive measure that can be reasonably manipulated, and extension of the open season seems the logical method of achieving added exploitation. There are no means for

predicting the increase in catch that might result for abolishment of all seasonal restrictions. This would depend on the quality of fall angling. There are many days in winter when weather would permit angling (Cayuga Lake does not normally freeze). If the present estimate of natural mortality is essentially correct, substantial increases in the rate of fishing could take place without affecting the total mortality rate.

There seems to be no serious objection to additional exploitation of lake trout in Cayuga Lake. However, if seasonal restrictions in Cayuga Lake were reduced or removed it would be advisable to do likewise in the other Finger Lakes wherever possible, lest fishing in the area be too heavily concentrated in Cayuga Lake. The available data and the similarity of population characteristics suggest this, but there are two major differences, Cayuga Lake lacks rainbow trout and naturally perpetuated stocks of lake trout.

Wiley, R. 1978. The rationale of fishing regulations. Wyoming Wildlife 42(9) : 21-26.

Open/Closed Seasons

Christie, W. J. 1978. Seasonal and area controls. p. 15-16 *In* A Study of Freshwater Fishery Regulation based on North American Experience. FAO Fisheries Technical Paper No. 180. Food and Agriculture Organization of the United Nations. Rome, Italy.

Fishing seasons seldom limit harvest in a significant way. Technically, the time of year a fish is caught has little to do with the perpetuation of the stock to which it belongs. Species, which provide early care for eggs and young, offer an exception to this generalization.

Dickenson, F. B. 1898. The protection of fish and a closed season. Transactions of the American Fisheries Society 27 : 32-46.

Murray, A. R. 1979. The lake trout of Whelan Bay, Whiteswan Lakes, Saskatchewan: Status and management. Fisheries Manuscript Report No. 6. Saskatchewan Environment and Resource Management. Regina, Saskatchewan. 44 p.

A creel census conducted, during the winter of 1978-79, revealed that the lake trout (*Salvelinus namaycush*) stock has been severely over-fished. It is estimated that anglers landed a total of 3,521 kg, or 1.85 kg/ha from December, 1978, to May, 1979. The estimated annual landings could be more than twice these values. Almost 94% of the trout landed by the anglers were immature. The age at full recruitment was 4 years; that the age maturity was 5 years. The slope of the right limb of the catch curve was steep, indicating a mortality rate of 86%, and concave, indicating heavy exploitation. Lake trout populations are not abundant in any of their habitats, and they have a low productivity rate. Three management objectives were identified, and three management options were proposed for achieving them. The options include doing nothing, imposing a complete

moratorium on lake trout fishing for several years, and allowing some fishing to occur in a four-month open season and supplementing the stock by planting fingerlings. A 'user pay' policy was also proposed and a means of implementing it was discussed.

Reckahn, J. A. 1961. Evaluation of an extended season for lake trout and rainbow trout in Cayuga, Seneca and Skaneateles Lakes. M. Sc. Thesis. Cornell University. Ithaca, New York. 109 p.

Ryan, P. A. and H. D. Howell. 1985. The 1985 experimental lake trout fishery in Squeers Lake with background notes concerning lake trout assessment studies. Quetico Mille Lacs Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Thunder Bay, Ontario.

Squeers Lake was chosen for long term fisheries assessment in 1978, as an example of a lake trout/northern pike community with an intensive sport fishery. It is one of a group of six lake trout lakes located 100 km WSW of Thunder Bay, Ontario for which sport fishing has been controlled by closure because of overharvest since 1979. Five of these lakes (Grouse, Hood, Myrt, Partridge and Watershed Lakes) were reopened to angling in 1981 for the restricted season of June 1 to September 15, annually. Squeers Lake remained closed to lake trout angling.

Fisheries assessment studies began in 1982 with the initial goal of determining the status of lake trout. It rapidly became apparent that lake trout were abundant and that we could consider reopening the fishery. The report describes the rational for and the types of experimental designs adopted for both population assessment and the lottery sport fish fishery.

Sein, R. and B. Wisenden. 1989. An assessment of the winter lake trout fishery in Thunder Bay District following the implementation of a shortened season in 1984. Ontario Ministry of Natural Resources. Thunder Bay, Ontario. 38 p.

The winter lake trout angling season in Thunder Bay District inland lakes was shortened to one month in duration from over four months, effective March 15, 1984. Four lakes with pre-closure creel data from 1981 and 1982 (Greenwater, Burchell, Huronian and Rudge) were creel surveyed during the 1985 and 1988 winter fishery in order to assess the effect the season reduction had on effort, harvest and catch-per-unit-effort (CUE). Sample sizes for catch, effort and fish attribute data were small from Burchell, Huronian and Rudge lakes. Greenwater Lake provided good catch, effort and fish attribute data. Greenwater Lake data indicated that the shortened season significantly reduced the effort and the harvest of lake trout. Reductions are probably due to the late season closure, a time when effort and harvest are usually greatest. Older and larger trout were harvested from Greenwater Lake in 1988 compared to 1981. Pooled CUE data between pre and post-season length change indicated an increase in CUE over time.

Catch and Possession Limits

Brouillard, K. D. 1963. Economic factors related to lake trout quotas on Lake Superior. United States Fish and Wildlife Service. Fishery Industrial Research 2(2) : 4 p.

In some fisheries a quota on catch as a method of management has proved successful insofar as physical yield is concerned. This method, however, has been based primarily on biological concepts, with little concern for the economic aspects.

The philosophy of management should include a consideration of economic rent. This rent can be obtained by limiting costs, that is, effort, as well as by limiting production. The combination of a quota on catch and a limitation on amount of gear will produce both biological and economic benefits.

The lake trout fishery on Lake Superior presents an opportunity to apply economic as well as biological principles to the management of an entire waterbody. If both of these factors are considered in the regulation of the fishery, the industry will be stronger in its longterm operations.

Linton, B. C. and M. J. Hansen. 2001. Statistical catch-at-age models for lake trout in Wisconsin waters of Lake Superior. p. 103-104 *In* Abstracts from the 131st Annual Meeting of the American Fisheries Society. Phoenix, Arizona.

Lake trout (*Salvelinus namaycush*) were historically important in Lake Superior due to their economic and ecological value. Lake trout populations collapsed in the early 1950s due to overexploitation by the commercial fishery and predation by sea lamprey (*Petromyzon marinus*). Efforts to restore a naturally reproducing lake trout population included closure of the lake trout fishery, stocking of hatchery-reared lake trout, and control of sea lamprey populations. To evaluate the efficacy of these restoration efforts, we fit separate statistical catch-at-age models for hatchery-reared and native lake trout populations in the Wisconsin waters of Lake Superior during 1980-1999. Catches at age from state commercial and recreational fisheries, tribal commercial fisheries, and two standardized gillnet surveys were all included. Within each model, mortality was estimated separately for populations residing in refuge and non-refuge portions of the area. Recruitment and natural mortality were estimated using random walk functions. Sea lamprey-induced mortality was calculated external to the model fitting. Commercial fishing mortality and recreational fishing mortality were estimated during model fitting. Total allowable catch was derived from estimated stock size, which was estimated during model fitting, for the purpose of setting harvest quotas for state and tribal commercial and recreational fisheries.

Olver, C. 1969. Potential effects of reducing the daily catch limit of lake trout from 5 to 3. Manuscript Report. Ontario Department of Lands and Forests. Sault Ste. Marie, Ontario. 14 p.

The relationships of potential harvest reduction on catchability, potential harvest reduction yield, and yield on catchability as determined by unweighted regression

analyses were all highly significant. Generally, the potential for harvest reduction was low in lakes with a catchability of less than 10. Overexploitation was not evident in lakes with a catchability of less than 10. A reduced daily limit would not be totally effective as a means of preventing excessive harvests. Additional and more stringent measures may be required to regulate the harvest in some lake trout lakes.

Porch, C. E. and W. W. Fox. 1990. Simulating the dynamic trends of fisheries regulated by small daily bag limits. Transactions of the American Fisheries Society 119 : 836-849.

We developed an algorithm for simulating the effects of potential bag limits. The algorithm uses statistical distributions to model frequency distribution of catch-per-trip. The moment equations of the distribution are keyed to stock abundance and the coefficient of fishing mortality rate, which allow the model to reflect the dynamics of the fishery. The catch with bag limit is calculated by censoring the simulated distribution. We establish the conditions under which compounded Poisson distributions, such as the negative binomial, can be expected to provide adequate models for the catch distributions of recreational fisheries. We also discuss the assumptions that underlie the method of censoring catch-per-trip distributions, and, where appropriate, suggest alternative models. An example is developed in which we use the negative binomial distribution to model catch-per-trip and the familiar exponential model to simulate the change in stock abundance due to fishing mortality.

Schumacher, R. E. 1960. Some effects of increased angling pressure on lake trout populations in four northeastern Minnesota lakes. Division of Fish and Game. Minnesota Department of Conservation. St. Paul, Minnesota. Fish Series No. 3 : 20-42.

Four popular Minnesota trout lakes were studied to determine what effect recent changes in the seasonal angling pattern and increases in fishing effort are having on lake trout populations. Conclusions are based on creel census records and measurement of length, weight and state of gonad development of specimens sampled from the angler's catch. Trout Lake, which is readily accessible, was observed over a 9-year period (1953 through 1960), and Clearwater, Mountain and West Pike lakes, which are more accessible, were observed for a period of 3 years from 1954 through 1956.

Winter fishing pressure on lake trout has developed on Trout Lake to more than twice the summer pressure. Efficiency of the winter angler is more than twice that of the summer angler and he takes more than five times the number of fish in a season. Angling pressure on all four lakes was found to be rising sharply, while the catch-per-unit-of-effort declined sharply. On Trout Lake, the total catch declined as well. Nearly two-thirds of the fish caught were taken before they had attained a spawning size.

It is concluded that this fishery exhibits symptoms of over fishing, and a reduction of the possession limit from 5 to 3 is recommended. It is calculated that such a reduction would accomplish a saving of something over 16% under present conditions in these waters.

Stoffle, R. W., F. V. Jensen and D. L. Rasch. 1987. Cultural basis of sport anglers' response to reduced lake trout catch limits. Transactions of the American Fisheries Society 116 : 503-509.

The cultural domain of southeastern Wisconsin anglers along Lake Michigan was assessed from responses to a state-proposed reduction in the daily allowable catch of lake trout (*Salvelinus namaycush*). The study's baseline was an extensive random survey in 1980 of the area's anglers with respect to Lake Michigan fishery resources. The 1984 lake trout issue was addressed by a restudy involving a small dimensional subsample of 1980 respondents and was cross-validated with ethnographic interviews. The findings suggest that anglers have responded over time to the state's policy proposals in a manner consistent with a stable value system that is not seriously masked by changes in short-term attitudes about the fishery. The results further indicate that, once a good cultural database is established, the socio-cultural impacts of proposed fishery policies can be evaluated inexpensively by a restudy approach.

Size Limit Regulations

Anonymous. 1962. The lake trout: Its life history, ecology and management. Publication No. 233. Wisconsin Conservation Department. Madison, Wisconsin. 15 p.

Trout stocked at six-inch yearlings in the Apostle Island area can within three years make significant contributions to the fishery at a size of 17 inches. Lake trout populations in Wisconsin display good growth and no problems exist with populations composed of small-sized individuals. Females are mature at lengths over 24 inches long and males mature at about 24 inches. With the minimum length set at 17 inches it is possible that many lake trout are being caught before maturity. Harvest under present regulations is intensive whether as a commercial fishery, or sport fishery with a bag limit of only two fish. Some biologists think the minimum size limit should be increased.

Armstrong, K. 1989. Proceedings of a slot limit seminar. Ontario Ministry of Natural Resources. Timmins, Ontario. 22 p.

Auclair, R. P. 1979. Togue – Will today's limits ruin tomorrow's fishing? Maine Fish and Wildlife. Fall 1979 : 4-7.

Burr, J. M. 1991. Length limit regulations as applied to Alaskan lake trout fisheries – A synthesis of available data with recommendations. Fishery Manuscript No. 91-5. Alaska Department of Fish and Game. Anchorage, Alaska. 28 p.

This study was undertaken to estimate the length and age at which lake trout (*Salvelinus namaycush*) become sexually mature in a variety of lakes in Alaska. Probit analysis was used to estimate length and age at first, median, and complete maturity for lake trout from 11 populations. Ages at which lake trout matured among the populations were quite variable. Ages at 50% maturity for

females ranged from 4.9 to 14.3 years. Males generally matured at a younger age than did females. The estimates of age at maturity were within the range of estimates reported from other areas. Estimates of length at maturity were less variable among the populations studied. Lengths at 50 percent maturity for females ranged from 348 to 481 mm FL and have a positive correlation to lake surface area. The estimates of length at maturity for lake trout from these Alaskan lakes were generally less than those reported from other areas. The effects of latitude, altitude, lake size, and available forage on the sexual maturity of lake trout are examined. Length limit regulations applied to lake trout populations in lakes of greatly different surface area sizes, even within a small geographical area, are unlikely to be effective at providing adequate protection for lake trout from harvest through at least one spawning.

Favro, L. D., P. K. Kuo and J. F. McDonald. 1980. Effects of unconventional size limits on the growth rate of trout. Canadian Journal of Fisheries and Aquatic Sciences 37 : 873-876.

A computer model was used to study the genetic effects on a general trout population that was subjected to selective fishing with unconventional size limits; both a minimum and maximum size were specified. The model predicts that such window size limits will not have their intended effect, i.e. to increase the percentage of larger fish in the population.

Ferreri, C. P. and W. W. Taylor. 1997. Role of fishing and sea lamprey-induced mortality in the rehabilitation of lake trout in the US waters of Lake Superior. p. 72-77 *In* D. A. Hancock, D. C. Smith, A. Grant and J. P. Beumer [eds.]. Proceedings of the 2nd World Fisheries Congress: Developing and Sustaining World Fisheries Resources, The State of Science and Management. Queensland, Australia.

Efforts to rehabilitate lake trout populations, which historically supported an important commercial fishery in Lake Superior, have met with limited success due to continuing excessive mortality by sea lamprey predation and commercial fishing. The role of these mortalities in lake trout population dynamics was evaluated using a Leslie projection matrix to calculate the finite rate of population growth (lambda.). Elasticity analysis indicated that survival, particularly during the pre-reproductive ages, made the greatest contribution to the lake trout population growth rate. Using sensitivity analysis, it was found that reducing fishing mortality had a greater effect on the population growth rate than reducing sea lamprey-induced mortality by an equal percentage. Fishery managers can reduce fishing mortality of pre-reproductive lake trout by increasing the legal size limit thereby increasing their population growth rate in Lake Superior and facilitating their rehabilitation to historic levels of abundance.

Hicks, F. 1989. Experimental slot size limits for lake trout in Algonquin Park, 1989 Progress Report. Algonquin Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Whitney, Ontario. 5 p.

Progress concerns and results from the Experimental Management Project of lake trout on Smoke Lake are presented with respect to the slot size limits, and hooking mortality.

Hicks, F. 1994. Early response of lake trout to a slot size limit. FAU Update No. 94-3. Algonquin Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Whitney, Ontario. 2 p.

The Algonquin Fisheries Assessment Unit (AFAU) has been monitoring the effects of a new slot size regulation on the lake trout population of Smoke Lake, a 607 ha lake located along the Highway 60 corridor of Algonquin Park. The lake trout in this lake grow fast as a result of feeding primarily on lake herring (cisco) and other fish, and thus, are susceptible to angling 2 to 3 years before reaching sexual maturity. Under the slot size regulation enacted in 1989, lake trout between 40 and 56 cm total length may not be kept by anglers. The rationale for this legislation is to re-establish a stable lake trout population by allowing a greater percentage of lake trout to mature and reproduce, particularly first- and second-time spawners.

Prior to 1989, anglers kept about 88% of the lake trout caught, while in 1992 only 55% of the trout caught were harvest. Using pre-1989 data, it could be speculated that, in the absence of the slot size regulation, 211 lake trout would have been harvested in 1992 rather than 131. The slot limit appears to have reduced the lake trout harvest by 38%.

Angler's reaction to the new regulations has been mixed. In some cases, it has been favourable because catch rates have improved and harvest of large trout beyond the upper slot limit is possible. In addition, there appears to be a greater acceptance of catch-and-release angling in Algonquin Park. Most of the negative comments are from anglers who only caught lake trout in the protected slot (40-56 cm). These fish cannot be legally retained. Some anglers were concerned about the mortality of released trout, although studies conducted elsewhere suggest that for lake trout hooked in the jaw, this is not a serious problem. If the lake trout population continues to improve and CUEs increase, this will help to diffuse much of the negative reaction to the regulation. We will continue to monitor the effects of this new regulation on the lake trout population of Smoke Lake.

Legault, M., H. Fournier, D. Nadeau and J. Benoit. 2001. Report on the protected slot limit for lake trout, 1993-1997: Status in Quebec. Société de la faune et des parcs du Québec, Direction de la recherche sur la faune, Direction de l'aménagement de la faune. 76 p. (English translation)

Following the 1993 introduction of a protected slot limit for lake trout, a monitoring program was established, with the first five-year status report planned for 1997-98. This first 5-year report reviews trends in sport fishing, angler satisfaction, compliance, and fish-population status. Recommendations are also offered on ways to adjust regulations based on the current situation for lake trout in the open lands ("territoire libre") of southern Quebec.

Sport-fishing surveys show that slot limits have resulted in reduced lake trout harvest, despite a fishing pressure which has remained relatively stable over recent years. However, this look at trends in fishing pressure and harvest is

restricted to the northwest and southern portions of Quebec, since no fisheries surveys were done in the northeast before implementation of the slot.

This reduction in harvest resulted in an improved situation for lake trout in the northwest and southern areas; stable or increasing abundance was observed for most waterbodies included in the study.

In the northeast, initiatives including implementing a protected slot limit, shortening the fishing season (season opens June 1st) and fish stocking were not successful at correcting the situation. Fishing pressure is higher there than anywhere else in Quebec.

Given the lack of effectiveness of the protected slot limit for slow-growth populations, which are predominant in the northeast and, to a lesser extent, in the northwest, we are recommending that the protected slot limit there be replaced with a 40 cm minimum size limit. A 40 cm minimum size limit would allow slow-growth populations to withstand fishing pressures that are equal to, or somewhat above, assessed pressures. Anglers would be allowed to keep large lake trout, however, they would have to release slightly more than the current protected size allows.

For some Mauricie populations, fishing pressure is probably already in excess of what a 40 cm minimum size limit could withstand, even though the fishing season currently opens on June 1st in fisheries Division 15. In order to counter the overexploitation still taking place in Division 15, it would be recommended to shift the opening of the lake trout fishing season there to July 1st.

For rapid-growth populations, the current protected slot limit has proven effective in countering overexploitation. In order to simplify the regulations somewhat, universal implementation of a minimum size limit across Quebec has been suggested. Consequently, a 48 cm minimum size should replace the rapid-growth slot.

This new regulatory regime for lake trout would result in a 40 cm minimum size limit for all areas north of the Saint-Lawrence (excluding Nouveau-Quebec and Division 19), with the exception of 28 waterbodies out of 415 inventoried lake trout lakes, where a 48 cm minimum size would apply.

For regions south of the Saint-Lawrence, a 48 cm minimum size limit would apply. A 40 cm minimum size would only apply to something on the order of 11 to 19 lakes.

Luecke, C., T. C. Edwards Jr., M. W. Wengert, Jr., S. Brayton and R. Schneidervin. 1994. Simulated changes in lake trout yield, trophies, and forage consumption under various slot limits. North American Journal of Fisheries Management 14 : 14-21.

In Flaming Gorge Reservoir, Utah-Wyoming, mean size of lake trout (*Salvelinus namaycush*) harvested by anglers has decreased. We hypothesized that this decline resulted from either overexploitation of lake trout by anglers or from a decline in lake trout growth owing to decreases in forage fish availability. While

investigations to examine these hypotheses were being developed, we wanted to examine the potential for increasing the size of lake trout harvested without dramatically increasing the consumption demand of the lake trout population on forage fishes. To accomplish this goal we used population models to examine survival patterns of lake trout under different slot limits. Results of the population model were used in bioenergetics simulations to examine the consumption demand of the lake trout population. Total yield, the number of trophy fish harvested, and the biomass of prey fish consumed by lake trout were examined for each of the seven harvest scenarios. Simulations indicated that the more restrictive slot length limits resulted in higher trophy catches, lower yields, and increased consumption of forage fish populations. Results suggested that the 28-26 inch slot limit provided a moderate increase in trophy catch while minimizing reductions in yield and increases in consumption demand. Examination of tradeoffs among these fishery and community responses can guide management decisions and help identify factors that should be monitored during a management program.

Ontario Ministry of Natural Resources. 1994. Proposed management for naturally reproducing populations of brook trout and lake trout in south central Ontario. Brook Trout/Lake Trout Management Committee. Toronto, Ontario. 38 p.

Of the 195 lake trout lakes that have or may be able to support naturally reproducing populations, approximately 59% are experiencing over-fishing. New management actions are required to bring lake trout harvests to sustainable levels. A slot size limit, a minimum size limit for three years followed by a slot size limit, and a winter and spring season closure are proposed options for attaining a sustainable harvest. Two of these options require the release of some fish. The use of organic bait causes a high mortality of released fish. As a result, a baitfish restriction (eg. a year round ban on the use of dead smelt and herring with an "artificial lures only" or a "one line only" and a live baitfish ban during the winter season) will accompany the size limit.

In considering size limits, it must be recognized that there are two general size categories of lake trout (small-bodied lake trout with a maximum size less than 2 kilograms and large-bodied lake trout with a maximum size greater than 3 kilograms). If a single size limit were adopted, lake trout populations in lakes with small-bodied fish would experience very different effects than those lakes with large-bodied fish. With this in mind, it is recommended that for naturally reproducing lake trout populations, lakes with populations of small-bodied lake trout be managed differently from lakes with populations of large bodied lake trout, and that only one harvest management option be adopted for each.

Perr, S. G. 1997. Lake trout growth response to a slot limit regulation. Project No. NH F-050-R/Job2/Project III. New Hampshire Fish and Game Department. Concord, New Hampshire.

Perr, S. G. 1998. Lake trout size and relative weight response to different length limit restrictions. Project NH F-050-R-14/Job 2/Project III. New Hampshire Fish and Game Department. Concord, New Hampshire. 20 p.

Longterm length and weight data sets for spawning lake trout were analyzed for four New Hampshire lakes. Objectives were to evaluate size structure and relative weight responses to the various length limit regulations.

Perry, S.G. 1997. Fish population statistics: Lake trout growth response to a slot limit regulation. Aquatic Resource Assessment Report. New Hampshire Fish and Game Department. Concord, New Hampshire. 11 p.

Ricker, W. E. 1945. A method of estimating minimum size limits for obtaining maximum yield. Copeia 1945(2) : 84-94.

The "critical size" for a year class of fish is defined as the size at which the average instantaneous rate of natural mortality begins to exceed the average instantaneous rate of increase in weight. Assuming that what is true of the year class as a whole is also true, on the average, of the fish individually, the critical size can be used as a basis for estimating the best minimum size at which fish should be taken in order to achieve maximum production at the existing rate of fishing. The best minimum size varies with the rate of fishing, being zero when the latter is very small and approaching the critical size when fishing is very intensive. Possible secondary effects of a change in fishing intensity on the rate of growth of the fish make it unwise to extrapolate too far from existing conditions (i.e., the critical size may change). However such extrapolation is a useful guide to the minimum size which will probably be desirable following a moderate change in rate of fishing.

Siegler, H. R. 1960. Fish management problems. *In* Biological Survey of the Lakes and Ponds in Coos, Grafton, and Carroll Counties. Survey Report No. 8A. New Hampshire Fish and Game Department. Concord, New Hampshire. 40 p.

New Hampshire has a length limit of 15 inches on lake trout, the purpose presumably being to permit these trout to mature and spawn at least once. Studies now indicate that few lake trout in New Hampshire reach spawning size below 18 inches in length. In Squam Lake, for instance, it was found that lake trout do not reach maturity until they are about 22 to 24 inches long.

Trippel, E. A. 1993. Relations of fecundity, maturation, and body size of lake trout and implications for management in northwestern Ontario lakes. North American Journal of Fisheries Management 13: 64-72.

The life history traits of lake trout (*Salvelinus namaycush*) in six lakes that vary in conductivity are described, and an adaptive management strategy that is based on differences in lake trout growth, fecundity, and maturity schedule is recommended. Lake trout in low-conductivity lakes exhibited slower somatic growth, matured at an older age, attained maturity at similar or smaller body sizes, and were less fecund than lake trout in high-conductivity lakes. To prevent overfishing of fecund components of lake trout populations, managers may need to restrict the harvest of females larger than 550 mm in fork length from low-conductivity lakes, whereas in high-conductivity lakes, regulations should limit removal of females that are 600 mm or larger in fork length. Extreme inter-population differences in adult size structures support a change in management

strategy, a change from a single region-wide regulation to lake-by-lake regulations that reflect lake conductivity and prey type base.

Fish Sanctuaries

Edsall, T. A., C. L. Brown, G. W. Kennedy and T. P. Poe. 1992. Lake trout spawning habitat in the Six Fathom Bank-Yankee Reef lake trout sanctuary, Lake Huron. Journal of Great Lakes Research 18(1) : 70-90.

Attempts to re-establish self-sustaining stocks of lake trout (*Salvelinus namaycush*) in the lower four Great Lakes, where the species was extinguished in the 1950s and 1960s, have been largely unsuccessful. To avoid many of the problems believed to be contributing to this failure, the fishery management community recently established several sanctuaries in the offshore waters of the Great Lakes where the development and protection of self-sustaining stocks of lake trout would be a primary management objective. One of these, the Six Fathom Bank-Yankee Reef sanctuary, was created in the southcentral portion of Lake Huron. This sanctuary covers 168,000 hectares and includes shallower portions of the Six Fathom and Ipperwash scarps, which are major bathymetric features in the southern half of the lake. Historical accounts describe Six Fathom Bank as the most important lake trout spawning ground in the lake. Here we present the results of lake bed surveys conducted in the sanctuary with side-scan sonar, underwater videocamera systems, and a small research submarine. Our observations of the lake bed are consistent with what is known of the bedrock statigraphy, glacial history, and karst geomorphology of the Lake Huron basin. Most of the loose rock we found seemed to be derived from local carbonate bedrock formations, although non-carbonate rock probably from Precambrian sources to the north was also present in some areas. Much of the bedrock and loose rock displayed karst solution features described for the Bruce Peninsula on the Ontario shoreline. Our surveys revealed substantial areas of lake bed at water depths of 26-36 m that resembled suitable spawning and fry production habitat for the shallow water strains of lake trout that are the focus of rehabilitation effort. Low mid-lake nutrient levels documented recently by others and the extremely high abundance of *Mysis relicta* (an important item in the diet of young lake trout) that we documented on Yankee Reef also contributed to our evaluation of the sanctuary as a site with high potential to support a self-sustaining population of lake trout.

Madenjian, C. P. and T. J. DeSorcie. 1999. Status of lake trout rehabilitation in the northern refuge of Lake Michigan. North American Journal of Fisheries Management 19(3) : 658-669.

The Northern Refuge in Lake Michigan was established in 1985 as part of a rehabilitation program to stock yearling lake trout (*Salvelinus namaycush*) in areas with the best potential for success. Stocking of hatchery-reared lake trout within the refuge began in 1986 at three reefs: Boulder Reef, Gull Island Reef, and Richards Reef. On each reef from 1991 to 1997 we conducted gill-net surveys during the fall spawning season to evaluate performance of adult lake trout, and we conducted beam trawl surveys for naturally reproduced age-0 lake

trout in the spring. Criteria to evaluate performance included spawner density, growth, maturity, and mortality. We found no evidence of natural reproduction by lake trout from our surveys. Nevertheless, density of spawning lake trout on Boulder Reef (69 fish/305 m of gill net/night) and Gull Island Reef (34 fish/305 m of gill net/night) appeared to be sufficiently high to initiate a self-sustaining population. Growth and maturity rates of lake trout in the Northern Refuge were similar to those for lake trout stocked in the nearshore region of Lake Michigan. In the Northern Refuge, growth rate for the Marquette strain of lake trout was slightly higher than for the Lewis Lake strain. Annual mortality estimates from catch curve analyses ranged from 0.46 to 0.41, and therefore, these estimates approached a level that was considered to be sufficiently low to allow for a self-sustaining population. Thus, it appeared that the lack of evidence for natural reproduction by lake trout in the Northern Refuge should not be attributed to inability of the population to attain a sufficiently large stock of spawners.

Martin, N. V. and N. S. Baldwin. 1948. Effects of the alternate closure of Algonquin Park lakes. The Canadian Fish Culturist 14 : 26-38.

The quality of lake trout fishing in the lakes on the closure plan has not differed materially from the quality in those lakes open to fishing in consecutive years. There is no evidence that stronger year classes have arisen in closed years in three lakes during the period 1939 to 1943. However, the data at hand for lake trout reflects the effects of closure years in one lake during the period 1944 to 1947. Whether this will change with present fishing pressure, which is comparatively heavy, is yet to be seen.

Pycha, R. L. 1982. Performance and protection of stocked and native lake trout. p. 214 *In* Great Lakes Fishery Commission Annual Meeting Minutes, June 9 and 10, 1982. Green Bay, Wisconsin.

Native, lean, fat, and humper lake trout in offshore waters of Lake Superior recovered to where populations are self-sustaining wherever a substantial residue population of immature fish was still present when sea lamprey control became effective. In inshore waters, the predator-prey ratio was still too high to allow many lake trout to survive to maturity for 5-8 years after the lamprey control became effective because residual trout populations were too small and intensive stocking was begun too late. Lake trout from the intense stocking of the mid-1960s did reach maturity and reproduced successfully, but appear to have been much less efficient than the native stocks. The key to rehabilitation of self-sustaining stocks appears to be development of massive spawning stocks by stocking intensively and by restricting fishing for lake trout. Lack of control of fishing has retarded rehabilitation of self-sustaining stocks in Lake Superior, has thwarted progress in Lake Michigan, and threatens rehabilitation of Lake Huron and possibly Lake Ontario. Use of refuges for lake trout management is discussed.

Special Regulations

American Fisheries Society. 1995. Special fishing regulations for managing freshwater sport fisheries. American Fisheries Society Draft Position Statement. Fisheries 20(1) : 6-8.

Special fishing regulations are those that differ considerably from province-wide or statewide regulations. They are designed for site-specific application and are useful and effective tools for fishery management when applied on the basis of sound fisheries science.

Valid uses of special regulations include maintaining or protecting a unique fishery, managing a fishery with unique potential, reserving certain fisheries for specific angler activities (e.g., fly-fishing only, children's fishing areas), allowing liberal exploitation of highly productive or winter-kill prone waters, improving or maintaining fishery quality, and protecting threatened or endangered species.

The American Fisheries Society (AFS) policy for special fishing regulations for freshwater sport fisheries encourages:

1. Development of realistic and attainable goals and measurable objectives for a fishery.
2. Involvement of the angling public in all phases of planning, development, and implementation of a special regulation to help ensure public acceptance, support, compliance, and effective enforcement once the regulation is in place.
3. Assessment that includes recognizing fiscal and temporal constraints.
4. Recognition of unforeseen problems that arise during implementation and evaluation of special regulations to further the understanding of site-specific special regulations.
5. Communication of evaluation results to the public and to the professional community.

Latta, W. C. 1975. Effects of "trophy" and "fish-for-fun" regulations on fish populations in lakes of Sylvania. Fisheries Research Report No. 1826. Michigan Department of Natural Resources Fisheries Division. Ann Arbor, Michigan.

The 21,000 acre Sylvania Recreation Area, part of the Ottawa National Forest, in Gogebic County, Michigan, was opened to the public as a semi-wilderness in 1967. Fishing was permitted under "trophy" and "fish-for-fun" regulations. Prior to the opening, the tract had been a private estate and fishing in the lakes had been light. Under the 'fish-for-fun" regulation, all fish taken had to be returned to the water. Under the "trophy" regulation, bass could not be kept unless they were a minimum size of 18 inches, lake trout 30 inches, walleye 20 inches, and northern pike 30 inches, while for other fish there was no size limit. The creel limit for the first group, under the "trophy" regulation, was two singly or in combination, while for the second group it was ten fish daily. Only artificial lures could be used.

The fish populations have been monitored with experimental gill nets in October of most years. In 1966, before the tract was opened to the public an attempt was made to sample the fish populations in most of the lakes. In succeeding years, of the eight lakes, four were under "trophy" regulation, two were under the "fish-for-fun" regulation, and two had the regular statewide regulations. Judging from catch-per-effort of the smallmouth bass in the gill net collections, bass 18 inches or larger, as well as those in the category 15.0 to 17.9 inches, have decreased substantially in numbers under the "trophy" regulation. Because of poor samples no judgement can be made on the change in abundance of bass under "fish-for-fun" and statewide regulations. There were no obvious changes in numbers of lake trout, walleyes and northern pike. With the decrease in large, old bass there was no increase in numbers of yellow perch or white sucker, with the exception of the latter species in one lake. As a result of the decreases in numbers of large bass the fishing regulations for 1975 were changed; under new regulations no bass may be kept regardless of size. Minimum sizes for lake trout, walleye, and northern pike remain the same. For these three, only one fish may be kept each day. For the other species, the daily limit is ten singly or in combination, and there is no size limit. Only artificial lures may be used.

Ontario Ministry of Natural Resources. 1991. An evaluation of the daily angling validation tag program. Border Water Working Group. St. Francis and Kenora Districts. Ontario Ministry of Natural Resources. Kenora, Ontario. 38 p.

Ontario Ministry of Natural Resources. 1998. The Clearwater Bay lake trout angling tag. Update No. 98-3 Lake of the Woods Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Kenora, Ontario.

Studies conducted by the Lake of the Woods Fisheries Assessment Unit (FAU) had identified that lake trout in Clearwater Bay and adjacent Echo Bay and Cul de Sac, located west of Kenora, at the north end of Lake of the Woods, were threatened by overfishing and loss of both spawning and deepwater summer habitat. Winter angling, which accounted for most of the annual effort and lake trout harvest in this area had grown dramatically during the early 1980s. Lake trout harvests had increased to over twice the estimated annual sustainable yield for these basins by 1987. Closure of the winter fishery in 1988 resulted in redistribution of angling effort and harvest to the open water season, without a reduction in annual harvest. By 1989, lake trout harvest during the open water season exceeded previous winter harvest levels.

The Clearwater Bay Lake Trout Angling Tag program was introduced in the spring of 1991, as part of an overall strategy designed by MNR and a public advisory group to address the decline of lake trout in this area. Its primary purpose was to maintain/increase the trophy lake trout fishery in the Clearwater-Echo-Cul de Sac area by reducing harvest. It was hypothesized that tighter harvest controls would decrease fishing mortality, increase lake trout survival and lead to detectable improvements in both the fishery and lake trout spawning populations.

The Clearwater Bay Lake Trout Tag system has proven to be effective in reducing harvest without limiting angling opportunities. Enforcement personnel

have observed a high degree of program compliance amongst most user groups. Administration of this system is well suited to an MNR partnership with client groups.

Schneider, J. C. and R. P. Juetten. 1989. An evaluation of special fishing regulations on Sylvania lakes. Fisheries Technical Report No. 89-9. Michigan Department of Natural Resources. Ann Arbor, Michigan. 15 p.

Limited access and special fishing regulations have maintained a semi-wilderness aura and preserved unique populations of large-sized bass and other game fish in the lakes of the Sylvania Recreation Area. Smallmouth bass populations, not adequately protected by trophy fishing regulations, have recovered under no-kill regulations. As of the 1980s, large bass were as frequent at four out of five lakes as they had been in 1966, the baseline year. The walleye population in Whitefish Lake, protected to some extent by trophy regulations, has been maintained. Trophy lake trout have apparently become rare in Clark Lake, but 10- to 30-inch trout have probably been protected to a considerable extent. Compared to lakes with normal statewide fishing regulations, both on the Sylvania boundary and elsewhere in Michigan, the populations and fisheries of Sylvania lakes are outstanding.

Catch-and-Release Regulations

Barnhart, R. A. 1989. Symposium review: Catch-and-release fishing - A decade of experience. North American Journal of Fisheries Management 9 : 74-80.

This paper provides a synopsis of the 1987 symposium "Catch-and-Release Fishing - A Decade of Experience", gives a brief history of the catch-and-release concept, and presents related research needs. Twenty-three presenters provided current information concerning catch-and-release of a variety of freshwater and marine sport fish. Catch-and-release fishing was first tried in the Great Smoky Mountains National Park in 1954. Today, most states and provinces in North America have catch-and-release programs on some waters. Catch-and-release regulations must be selectively applied; productivity of the environment and longevity of the fish are important considerations and strict compliance with special regulations by anglers is necessary for success. Anglers will accept these regulations when professionals present sound biological evidence to demonstrate the need. An increased use of catch-and-release regulations was reported in non-trout fisheries, especially those for largemouth bass (*Micropterus salmoides*). Traditionally, most saltwater sport fish have not been released but, because of increased pressures on declining stocks, catch-and-release fishing now is promoted by concerned saltwater angler organizations.

Barnhart, G. A. and R. Engstrom-Heg. 1984. A synopsis of some New York experiences with catch-and-release management of wild salmonids. p. 91-101 *In* F. Richardson and R. H. Hamre [eds.]. Wild Trout III: Proceedings of the Symposium. Trout Unlimited. Yellowstone, Montana.

Catch-and-release regulations are an effective tool for accomplishing a variety of wild salmonid management objectives in New York. Absolute or partial harvest restrictions have been successfully employed to:

1. Increase angler catch rates of wild brown, rainbow and lake trout.
2. Reduce the need for stocking to maintain acceptable stream brown trout and lake trout fisheries.
3. Restore or enhance wild brown, rainbow and lake trout populations.
4. In limited instances, increase the maximum size, abundance and catch rate of large stream trout.

Attainment of these objectives has typically been at a cost in take-home yield, but size limit protection has frequently produced increased yields. Implementation of catch-and-release regulations has typically caused short-term depression in angler use followed by partial or complete recovery within several years. Neither lack of angler compliance nor hooking mortality have precluded attainment of catch-and-release objectives. Short and long term impacts of harvest restrictions have frequently been different and distinct. Evaluation schemes for catch-and-release management programs should include several years of post-implementation monitoring.

Clark, R. D., Jr. 1983. Potential effects of voluntary catch-and-release of fish on recreational fisheries. North American Journal of Fisheries Management 3 : 306-314.

Anglers frequently release fish that are large enough to keep under prevailing fishing laws. However, fisheries managers usually estimate only fishing effort and number of fish harvested, when assessing a fishery, and simply assume this voluntary release of fish is unimportant. In this study, I examined how the release of legal fish might affect a fishery. I modified the classical yield-per-recruit model so that the total mortality rate (Z) was partitioned into three components: natural (M), fishing (F), and hooking (H) mortality rates. I used another parameter (*p*), representing the probability a legal fish was released when captured, to modify the levels of fishing and hooking mortality. I applied the model to four fisheries with widely different characteristics of growth, mortality and fishing: brook trout (*Salvelinus fontinalis*) in a small stream; largemouth bass (*Micropterus salmoides*) in a medium-sized reservoir; brown trout (*Salmo trutta*) in a medium sized river, and northern pike (*Esox lucius*) in a typical lake. I varied the probability of releasing a legal fish (*p*) while keeping all the other model parameters constant. Results indicated that the release of legal-sized fish reduced the total mortality rates of the populations. As the release rates increased:

- Total catch and catch of trophy fish increased (i.e., fish harvested plus fish caught and released).
- Total harvest decreased.
- Harvest of trophy fish remained relatively constant.

I believe the effects of voluntary release can be assumed negligible if less than 10% of the legal fish caught are released, but release rates higher than 10% changed the interpretation of conventional creel census estimates of catch and

fishing mortality. The actual catch will be higher than indicated by a survey of fish in the creel and the fishing mortality rates computed from these data will underestimate the true catch rate. Thus, the relationship between catch and effort in recreational fisheries will change as the views of the fishermen on releasing fish change. Managers of sport fisheries need to estimate the voluntary release rate, along with harvest and fishing effort, if they want to assess a fishery accurately.

Hulsman, P. and C. Brady. 1991. Mortality rate and factors affecting mortality of angled and released lake trout (*Salvelinus namaycush*). Haliburton-Hastings Fisheries Assessment Unit, Ontario Ministry of Natural Resources. Bancroft, Ontario. 9 p.

Lake trout angled from a small (213 ha) inland lake during the period of thermal stratification were tethered to a buoy line for a period of 48 hours. We looked for relationships between mortality and a set of factors including fish size, depth of capture, surface water temperature, landing time, handling time, time spent in a livewell, bleeding, hook placement, and hook type.

The mortality rate for the 32 fish ranging in size from 187 to 482 mm for length was 28%. We feel strongly that stresses related to our gear and procedures contributed greatly to this mortality and that in a real catch-and-release situation, mortality rates would be much lower. Handling time and hook placement showed significant relationships to mortality.

Ontario Ministry of Natural Resources. 1990. Fishing in northwestern Ontario – Catch-and-release. Ontario Ministry of Natural Resources. Toronto, Ontario. 16 p.

Suggestions for anglers to ensure released fish survive by practicing good handling techniques to minimize injury and stress to the fish. Handling techniques discussed are:

- Careful gear selection (recommended line strength for a lake trout with an average weight of 2-3 kg or 4-7 lb is 3.6-4.5 kg or 8-10 lb).
- Artificial lures as an alternative.
- Use of barbless hooks.
- Capture correctly .
- Proper removal of hooks using long-nosed pliers.
- Administer aid by holding the fish upright in the water and move it forward and backward slowly, so that fresh water flows over the gills.
- Minimize damage of the fish by keeping the body in a horizontal position.
- Small hooks should be left imbedded and the line cut, quick strike rigs will help prevent deep ingestion.
- Do not release fish on extremely cold days (more than 20°C below zero or 0°F) if they are taken out of water or release from a heated ice hut.
- Minimize the time fish are kept out of water.
- Lake trout can successfully be released in the heat of the summer.

Quinn, N. and F. Hicks. 1988. Catch-and-release of lake trout – An experimental management program to study harvest control regulations in Algonquin Provincial Park. Manuscript Report. Algonquin Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Whitney, Ontario. 10 p.

New fishing regulations aimed at rehabilitating or improving the quality of fishing will come into effect in 1989. One of the new regulations is a slot limit on lake trout whereby, trout shorter than 40 cm in length and longer than 56 cm may be kept, but trout in the slot must be returned to the water immediately. Although recent studies indicate that survival is good, additional studies were warranted on lakes in the park during the traditional spring fishery. Anglers caught lake trout under actual fishing conditions and park staff attached a variety of tags to assess survival. Ultrasonic pinger tags were attached to the lake trout in the slot and were followed over the next 30 days. Overall survival of the lake trout was 82% which is consistent with other studies. Large lake trout can be released successfully, if proper care is exercised, however, small lake trout appear to be particularly vulnerable to catch-and-release. This is primarily due to severe hooking or snagging, however, these fish are legal under the new regulations and can be kept.

Thurston, L. 1988. Research shows that lake trout survive "catch-and-release" fishing during open water season. Ontario Ministry of Natural Resources. News Release : March 1, 1988. Parry Sound, Ontario. 3 p.

Hooking Mortality

Dextrase, A. J. and H. E. Ball. 1991. Hooking mortality of lake trout angled through the ice. North American Journal of Fisheries Management 11: 477-479.

Lake trout (*Salvelinus namaycush*) were angled through the ice in shallow water (2-7 m) with live minnows on still lines and held for 48 hours to observe short-term hooking mortality. Air temperature varied from -14 to -8° C while angling took place. Five of 50 lake trout (10%) died within 48 hours of capture. All fish that died were hooked deeply in critical areas (gills, deep mouth, and stomach) and showed signs of bleeding. Three of four fish hooked in the gills died. Of the 23 fish hooked superficially in the mouth, none died.

Dotson, T. 1982. Mortalities in trout caused by gear type and angler-induced stress. North American Journal of Fisheries Management Supplement 2 : 60-65.

Mortalities of hooked and released trout were measured at four Montana state hatcheries in 1978. At Yellowstone River Trout Hatchery, cutthroat trout (*Salmo clarki*) caught by single barbless, single barbed, and barbed treble hooks and landed rapidly showed no significant mortalities. At Washoe Park Trout Hatchery, Big Springs Trout Hatchery, and Bluewater Springs Trout Hatchery, rainbow trout (*Salmo gairdneri*) caught and returned to water of five different temperature (47-61 F) showed mortalities that increased from 0 to 8.6% with

increasing water temperatures. All fish in temperature related tests were played to exhaustion before release.

Falk, M. R., D. V. Gillman and L. W. Dahlke. 1974. Comparison of mortality between barbed and barbless hooked lake trout. Environment Canada, Fisheries and Marine Service Research Branch, Central Region. Technical Report Series CEN/T-74-1. Ottawa, Ontario. 28 p.

Hawkins, R. 1994. Hooking mortality of lake trout summary. Algonquin Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Whitney, Ontario. 19 p.

Post-release mortality of lake trout has been explored in relatively few investigations, each conducted under different conditions using different methodologies. Dismissing the inconclusive results of some studies, provides a range of hooking mortality, 7-18% for open water lake trout fisheries. Hooking mortality rates for winter angling appear to be higher, from 10-24%. For temperate lakes in Ontario, the mortality rate of 15% is probably the best representative for lake trout.

- 90-95% of hooking mortality will occur within 48 hours after capture; Because the majority of deaths occur in a short period of time after capture, the major factor affecting mortality is physical damage.
- Bleeding and hook placement is the principal biological and physical variable that can affect hooking mortality.
- The practice of angling by set-lining using natural bait affected hook placement, damage, and subsequent fish mortality.
- Factors such as fishing method, size and type of hooks used were shown to have a role, albeit a less important role affecting hook placement in lake trout.

As regulation changes requiring catch-and-release of lake trout become necessary, careful consideration must be given to all the variables affecting hooking mortality, with special emphasis on those affecting hook placement. Hand-in-hand with regulation change is the need to educate the public in ethical procedures for proper hook removal, handling, and release of fish. "Quality" angling will only be achieved by educating anglers to respect and develop a responsibility toward natural resource management.

Kerr, S. J. 2001. A review of "fizzing" – A technique for swim bladder deflation. Fisheries Section, Fish and Wildlife Branch. Ontario Ministry of Natural Resources. Peterborough, Ontario. 13 p.

Fish which are quickly removed from deep water often display signs of depressurization. Symptoms include over-inflated swim bladders, hemorrhaging, erratic swimming behaviour and the inability to submerge when released Death can result from gas embolisms, internal organ damage, or from predation and exposure when unable to descend from the water surface.

Recently, a procedure known as "fizzing" has been developed in an attempt to artificially deflate gas from a distended swim bladder. The procedure involves puncturing the swim bladder through the musculature of the fish with a sharp instrument such as a hypodermic syringe.

Despite the relatively widespread use of this technique, particularly at competitive fishing events, there is considerable controversy about the merits of this procedure. Numerous North American jurisdictions either prohibit or discourage the practice of "fizzing".

There is a need for more exhaustive research on the practice of artificial air bladder deflation and the examination of alternate techniques for the successful release of fish which have been angled from deep water.

Pending further research and evaluation, the widespread use of "fizzing" should be discouraged in Ontario.

Klein, W. D. 1966. Mortality of trout caught on artificial lures and released by fishermen. Transactions of the American Fisheries Society 95 : 326-328.

An experimental program was initiated in 1961 at Parvin Lake, Colorado to provide fishermen with trout of larger sizes. To help achieve this objective, a 14-inch size limit was established and bait fishing and multiple hooks were prohibited. It was postulated that mortality of undersized trout caught and released could greatly reduce the number of fish reaching the size limit. Therefore, a study of this mortality was made in 1961 and 1962, and the results are presented here.

Overall losses of throwback trout hooked (on flies and lures) and released by fishermen at Parvin Lake were 11% or less. However, greater losses (22%) were indicated in the late season than the early season (10%). There was no significant difference in the rates for different species (rainbow vs. hybrid trout) or for different sizes of fish. Delayed mortality was somewhat greater than immediate mortality.

It was concluded that losses due to throwback mortality under the conditions described would not significantly affect the quality fishing program.

Lee, W. C. 1994. Hooking mortality of lake trout (*Salivelinus namaycush*) in high elevation Colorado reservoirs. M.Sc. Thesis. Colorado State University. Fort Collins, Colorado. 82 p.

Biotelemetry techniques were used to determine the influence of thermal and oxygen stratification of lake trout hooking mortality in Lake Granby, Colorado in 1990-1992. Mortality associated with method of capture, anatomical hooking site and hook type was examined.

Lee, W. and E. Bergersen. 1993. Lake trout hooking mortality. Colorado Division of Wildlife Research Review 2 : 48-49.

Lee, W. C. and E. P. Bergersen. 1996. Influence of thermal and oxygen stratification on lake trout hooking mortality. North American Journal of Fisheries Management 16(1) : 175-181.

We used dart tags and biotelemetry to determine the influence of thermal and oxygen stratification on the mortality of larger lake trout (*Salvelinus namaycush*) (>560 mm) that were hooked and released in Lake Granby, Colorado, in 1990–1992. During August and September, suitable thermal refuges (<12°C) contained inadequate dissolved oxygen (3 mg/L) for lake trout. Mortality was 87.5% for the fish released during this critical late-summer period, but only 11.7% for fish released when the thermal refuge contained adequate dissolved oxygen (>3 mg/L). We recaptured 5.7%, of fish marked in summer with dart tags and 10.1% of fish tagged during the rest of the year. Higher mortality of fish tagged in summer was probably caused by the lack of adequate dissolved oxygen in the thermal refuge during late summer. We believe that slot length limits for larger fish may not achieve management goals for Lake Granby because large lake trout have slow growth and high late-summer hooking mortality that may negate the intended benefit of slot limits.

Loftus, A. J., W. W. Taylor and M. Keller. 1988. An evaluation of lake trout (*Salvelinus namaycush*) hooking mortality in the upper Great Lakes. Canadian Journal of Fisheries and Aquatic Sciences 45 : 1473-1479.

Investigation of lake trout (*Salvelinus namaycush*) hooking mortality was conducted in Lakes Michigan, Huron, and Superior during 1984 and 1985. Fish were caught and handled by charter boat operators and sport fishermen. Mortality was estimated by returning hooked fish to the lake after tethering them to a line-buoy system. Overall hooking mortality was estimated to be 14.9% (95% C.I. = 7.4-25.7). Significantly higher mortalities occurred in fish that were not discovered to have been hooked and in fish of smaller size classes. In addition, lake trout that were hooked in internal regions produced a mortality of 71.4% whereas those hooked in the upper or lower jaw had a mortality of 6.9%. The depth from which the fish was angled, the temperature differential from this depth to the surface, gear type, and handling times had no significant impact on survival. These results support the use of size limits, creel limits, and season restrictions as effective methods to reduce sport fishing mortality of lake trout.

MacLean, N. G. and L. Normand. 1987. Factors affecting lake trout hooking mortality in eastern Ontario inland lakes. Manuscript Report. Rideau Lakes Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Sharbot Lake, Ontario.

Muoneke, M. I. and W. M. Childress. 1994. Hooking mortality: A review for recreational fisheries. Reviews in Fisheries Science 2(2) : 123-156.

Length-limit regulations and promotion of catch-and-release fishing have become increasingly important management approaches for recreational fisheries. We reviewed studies on catch-and-release (hooking mortality gathered from the existing fisheries literature and from a survey of fisheries management agencies in all 50 states, the U.S. government, all Canadian provinces, and selected academic and research institutions. We identified hooking mortality estimates for

32 taxa. Most studies dealt with salmonids, centrarchids (especially black basses, *Micopterus* spp.), and percids (especially walleye, *Stizostedion vitreum*). Within and among species, differences in percent mortality were reported in association with bait type (artificial vs. natural), hook type (number of hooks, hook size, and barbs), season/temperature, water depth (depressurization), anatomical location of hook wound, and individual size. Although most hooking mortalities occur within 24 hours, the use of initial plus delayed mortality provides a more complete estimate of mortality. Single hooks (especially when used in conjunction with natural baits) resulted in higher mortalities than treble hooks. Environmental conditions (notably high water temperature and low dissolved oxygen) are important to overall mortality related to hooking, playing and handling. Mortalities were highly variable; occasionally exceeding 30% among red drum (*Sciaenops ocellatus*), smallmouth bass (*M. dolomieu*), largemouth bass (*M. salmoides*), cutthroat trout (*Oncorhynchus clarki*) and catfishes (Ictaluridae), and 68% among spotted seatrout (*Cynoscion nebulosus*), and coho salmon (*O. kisutch*). Lake trout (*Salvelinus namaycush*) and pikes (Esocidae) had mortalities under 15%. The many variables potentially affecting hooking mortality may make optimal management of a particular species and water bodies difficult using regional-level (e.g., statewide) management regulations.

Nadeau, D. 1982. Hooking mortality among lure caught lake trout (*Salvelinus namaycush*). Ministere du Loisir, de la Chasse, et de la Peche, Service de l'Exploitation de la Faune, Direction Regionale de l'Abitibi-Temiscamingue. Noranda, Quebec. (English translation)

A study was conducted to investigate hooking mortality among lure-caught lake trout (*Salvelinus namaycush*) and to assess the impact of a regulation requiring anglers to release a portion of the lake trout they catch. The mortality rate was 11.5%; in every case, the fish had been hooked in the gill arches.

Nadeau, D. et J. LaPointe. 1991. Evaluation de la mortalite engendree par les engins de peche sportive chez le Touladi (*Salvelinus namaycush*). Ministere du Loisir, de la Chasse et de la Peche, Service de l'Amenagement et de l'Exploitation de la Faune. Rouyn-Noranda, Quebec. 26 p.

Oram, G. 1988. An evaluation of lake trout hooking mortality in Smoke Lake, 1988. Algonquin Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Whitney, Ontario. 13 p.

New fishing regulations directed at rehabilitating lake trout will be established in 1989. A slot limit on lake trout designed to protect breeding stock between 40 cm and 56 cm. Smoke Lake in Algonquin Provincial Park District was chosen and a catch-and-release experiment was undertaken on May 30 and 31, 1988 with the assistance of anglers within the Ministry of Natural Resources and the Whitney Game and Fish Club. Survival rates were established by attaching spaghetti tags, tethering, and sonic tracking. Three lake trout moved about Smoke Lake during the monitoring period indicating that angling caused little or no stress to these fish. Due to problems with tracking the remaining two lake trout, it is not clear whether they lost their transmitters or died on or about June 11, 1988. They did, however, survive for a period of 6 to 11 days, beyond the

critical 48 hours following release. These results reflect 0 to 40% hooking mortality for angled lake trout.

Persons, S. E. and S. A. Hirsch. 1994. Hooking mortality of lake trout angled through the ice by jigging and set-lining. Manuscript Report. Minnesota Department of Natural Resources. St. Paul, Minnesota. 13 p.

Hooking mortality was determined for 96 lake trout (*Salvelinus namaycush*) caught through the ice by jigging and by set-lining with large dead baits on Gunflint Lake, Cook County, Minnesota, in January 1991. The estimated mortality rate for all released lake trout was 24%; estimated mortality rates for lake trout caught by set-lining and jigging were 32 and 9%, respectively. Hooking location strongly influenced lake trout mortality. Mortalities of lake trout hooked in the gills or gut, inside the mouth, or in the lip were, 36, 29, and 0%, respectively. Seventy percent of the lake trout caught by set-lining were hooked in the gills or gut, compared with 9% of the lake trout caught by jigging. The lack of mortality for lip-hooked lake trout suggested that capturing fish from deep water (25-50 ft), handling in cold temperatures (-20 to 20ºF), fin-clipping, and cribbing had little effect on mortality during the study. High hooking mortality rates for lake trout taken by set-lining suggested that the use of this fishing method should be restricted when management strategies require the release of winter-caught lake trout.

Powell, M. J. and R. Hawkins. 1994. A review of the mortality of caught-and-released fish. Ontario Ministry of Natural Resources. Toronto, Ontario. 11 p.

A report summarizing lake trout hooking mortality studies. The overall hooking mortality for open water lake trout fisheries ranged from 7 to 18%. Overall hooking mortality for lake trout angled through the ice appeared to be higher, from 10-24%. The principal factor affecting post-release mortality of lake trout was bleeding and damage from hook placement. The mortality rates of lake trout hooked in critical areas (gills, esophagus, tongue and eyes) were much higher and in most cases significantly different than the mortality of those hooked in less critical areas (lip, jaw). Ninety-five percent of hooking mortality will occur within 48 hours after capture. Factors influencing hook placement are angling method and the use of natural bait appears to be the most important. Using natural bait causes hooking in critical areas approximately 59% of the time. Other factors such as water temperature, size of the fish and type of hook used have all been shown to influence hooking mortality of other salmonid species. From the various lake trout studies, smaller fish, warmer surface water temperatures and the use of barbed hooks, when investigated, all produce higher mortality rates, however, not to any level of significance. Another important factor affecting hook placement and hooking mortality is the need to educate anglers on the proper hook removal, handling, and release of fish.

Taylor, M. J. and K. R. White. 1992. A meta-analysis of hooking mortality of nonanadromous trout. North American Journal of Fisheries Management 12(4) : 760-767.

The results of 18 studies of hooking mortality of nonanadromous trout were integrated with meta-analysis. Studies were coded for all variables suspected of

having a relationship to rates of hooking mortality. The analysis showed that trout caught on bait died at higher rates than trout caught on artificial flies or lures, that fish caught on barbed hooks had higher mortality rates than fish caught on barbless hooks, that brown trout (*Salmo trutta*) had lower mortality rates than other species of nonanadromous trout, and that wild trout died at higher rates than hatchery-reared trout. Other variables, including size of hooks, number of hooks, and water temperature, did not show a statistically significant relationship to hooking mortality. The results of this review should assist fisheries management agencies in refining and developing policies regarding fisheries regulations.

Weilandt, P. 1987. Angling mortality of lake trout during a live-release derby on Lake Temagami. Manuscript Report. Ontario Ministry of Natural Resources. Temagami District, Ontario.

Wydoski, R. S. 1977. Relation of hooking mortality and sublethal hooking stress to quality fishery management. p. 43-87 *In* R. A. Barnhart and D. Roelofs [eds.]. Catch-and-Release Fishing as a Management Tool: Proceedings of Symposium 1977. Arcata, California.

The demand for quality fishing experiences has been increasing in concert with the increase in the number of anglers in the United States. "Catch-and-Release" fishing has been one tool used by fishery managers to produce "quality" angling with the logic that fish will be available to be caught several times and will reach larger sizes since they are allowed to live longer. Under light to moderate angling pressure, this concept works well in managing for quality fishing. However, the factors of hooking mortality or sublethal hooking stress may become important considerations for the manager in catch-and release fishing programs when pressure is high.

Initial hooking mortality is often linked with the type of terminal gear used by anglers and hook damage to vital organs such as the heart, or a gill. Since bait is often taken deeply by fish, this terminal gear has caused the highest mortality in fish (mean 25.0 percent, range 3.3 to 61.5 percent, N = 2,859). The average mortality to fish from barbed hooks on lures was 6.1 percent (range 1.7 to 42.6 percent, N = 3,625) while barbed hooks on artificial flies caused and average mortality of 4.02 percent (range 0.0 to 11.3 percent, N = 2,713). These hooking mortalities were determined in experiments that differed due to variables such as species of fish, size of fish, sample size, type of bait used, hook size, anatomical site of hooking, angling technique, and different water temperatures. Single hooks have usually caused higher mortality than treble hooks when used with bait or lures as the terminal gear. Also, the use of barbless hooks did not significantly reduce mortality when compared to barbed hooks but the use of such hooks reduces handling time of fish that could add to their survival after release.

Stress in fish can disrupt normal metabolic and osmo-regulatory functions in fish and various stresses are cumulative in their affect on fish. Hooking stress does not cause mortality in fish that are in good physical condition. However, hooking stress added to fish that are already under stress from adverse environmental conditions or pollutants may cause mortality of fish either directly or indirectly by

allowing them to become more susceptible to predators, diseases, or parasites. The delayed mortality that results from stress can be more important than the initial hooking mortality that is observed and must be taken into account by fishery managers in quality fisheries if the angling pressure is high or the fish are under adverse or stressful conditions.

The losses of fish to hooking mortality or hooking stress is probably not very important in the productive waters of the United States. However, such losses could be very important to management of quality fisheries in the less productive waters such as found in northern United States. In such waters, the most important factors to consider in the overall loss of fish from hooking mortality are species diversities of voracity of feeding, type of terminal gear being used by anglers, the anatomical site of hooking, and water temperature.

Fishery biologists may sometimes have the biological facts to solve a particular problem but may not be able to implement the solution because of economical, political, or sociological constraints. Fishery managers should be certain to adequately inform the public about their policies or programs and employ effective public relations to help influence politicians and the public about their policies or programs and employ effective public relations to help influence politicians and the public in the proper direction for the best management of U.S. waters for recreational fishing.

Angler Attitudes and Compliance

Thorn, W., S. Hirsch, S. Persons, J. Hirsch, and G. Siesennop. 1989. Attitudes of Minnesota trout anglers and their implications for management. Minnesota Department of Natural Resources Special Publication No. 143. Lake City, Minnesota. 54 p.

Wydoski, R. S. 1976. Angler responses to special regulations. Proceedings of the Annual Conference of the Western Association of State Game and Fish Commissioners 56 : 146-147.

It seems inevitable to some managers that information and educational programs will play a vital role in the management of fisheries in the future. If regulations are formed to provide various angling opportunities, these regulations must be explained to anglers and be accepted by them as being necessary. Angling regulations are of little value unless anglers obey them. Emphasis in the future will need to be on active information and education programs with the goal of prevention of the violation rather than on enforcement.

Ideally, angling regulations should be

1. Few in number.
2. Based on active and continuous research to determine their need.
3. Made by the Commission and not the Legislature.
4. Enforced by well trained conservatiόn officers who place the major emphasis on prevention rather than detection of the violation.

In addition to the biological ramifications of regulations, the political, sociological, and economic constraints cannot be discounted by the fishery manager. However, with the support of the anglers, the manager can overcome the hurdles of some of these constraints. We must have long-term but urgent goals of protecting our aquatic habitats, and short term goals to provide fish by applying management tools such as regulations that apply to specific situations.

APPENDIX 1. A summary of regulations for lake trout (*Salvelinus namaycush*) in Canadian provinces and U.S. states. Information was derived from the 2002 summary of fishing regulations for each jurisdiction.

Jurisdiction	Lake trout Present?	Open Season	Catch(Possession) Limits		Size Limits	
			Standard	Exception(s)	Standard	Exception(s)
Canada						
Alberta	Yes	June 16 – Aug. 31 All Year (stocked waters) June 1-Sept. 30; Dec. 1-Mar.31 Apr. 1-Nov. 30 Apr. 1-Aug. 31 June 16-Jan. 14 Sept. 1-Oct. 31 June 1-Aug. 31 May 8-Mar. 15 May 18-Sept. 14; Nov. 16-Mar. 31	5(5)	3(3) 2(2) 1(1) 3(3)	None	1 over 40 cm minimum 35cm 1 under 35 cm 1 over 35 cm 1 over 40 cm and 1 under 40 cm 1 under and none over 35 cm 1 over 65 cm
British Columbia	Yes	None Feb. 1- Oct. 14 Dec. 1-Sept. 30 Dec. 1-Sept. 14 May 1-Oct. 15 Apr. 1-Sept. 30 June 1-Nov. 30 Nov. 1-Sept. 14	4(8)	1(2) 2(4) 3(6) 0 2(2)	None (lakes)	Only 1 over 50 cm None over 50 cm Only one over 90 cm and none between 60 - 90 cm None under 30 cm None over 40 cm None under 30 cm None under 33 cm None under 25 cm Annual catch of 5 over 60 cm Only 1 over 60 cm
Manitoba	Yes	All Year (stocked waters)	2(2) sport licence 1(1) cons. Licence	1(1)	1 fish over 65 cm	None under 25 cm None over 65 cm
New Brunswick	Yes	May 1-Sept. 15 (streams) May 15-Sept. 15 (lakes)	5(5) of which only 2(2) lake trout	10(10) of which only 2(2) lake trout 3.5 kg plus 1 fish	45 cm minimum	None
Newfoundland & Labrador	Yes	Feb. 1-Apr. 15; May 15-Sept. 7 Mar. 1-Sept. 7 Feb. 1-Apr. 15;May 15-Sept. 15 Feb 1-Aug. 31	2(4)	None	None	None
Northwest Territories	Yes	None	3(5)	None	None	None

			Catch(Possession) Limits		Size Limits	
Jurisdiction	Lake trout Present?	Open Season	Standard	Exception(s)	Standard	Exception(s)
Nova Scotia	Yes	Apr. 15-Sept. 30 Apr. 1-Sept. 30	5(5)	2(2)	None	None
Nunavut	Yes	None	3(5)	None	None	None
Ontario	Yes	All Year Jan 1-Sept. 30; Dec. 1-Dec. 31 April 26 (last Sat.)-Sept. 30 Jan. 1-Sept. 30 Jan.1-March 15;May 10 (2nd Sat.)-Sept. 30 June 7 (1st Sat.)-Sept. 8 Apr. 25 (last Fri.)-Sept. 30 Mar. 8 (2nd Sat.)-Sept. 8 Jan. 1-Mar. 7; May 17 (Sat. before Victoria Day)-Sept. 30 Feb. 15-Mar. 15; May 17 (3rd Sat.)-Sept. 30 Feb. 15- Mar. 15; May 24 (4th Sat.)-Sept. 30 May 17 (3rd Sat.)-Sept. 30) Jan. 1-June 30 Feb. 15-Mar. 15; May 17 (3rd Sat.)-Sept. 14	3(3) sport licence 2(2) sport licence 5(5) sport licence 1(1) cons. licence 2(2) cons. licence	1(1) 1(2)	None	None between 40 cm and 55 cm (FL) Only 1 over 56 cm from Sept. 1-Sept. 30 Only 1 over 70 cm None between 33 cm and 40 cm Feb. 8-Mar. 31 & June 24-Aug. 31-only one of maximum 61 cm Not more than 1 less than 40 cm Not more than 1over 56 cm Not more than 1 greater than 40 cm and not more than 1 less than 40 cm Catch and release except for tag holders Border Waters-Maximum 56 cm from Sept. 1-Sept. 30
Prince Edward Island	No	-	-	-	-	-

			Catch(Possession) Limits		Size Limits	
Jurisdiction	Lake trout Present?	Open Season	Standard	Exception(s)	Standard	Exception(s)
Quebec	Yes	May 10-Sept. 2 May 3-Sept.2 Year Round July 1-Sept. 2 Apr. 25-Sept.7 June 1-Sept. 7 Apr. 26-Sept. 30 May 15-Sept. 15 Apr. 26-Sept. 2 May 17-Sept. 2 Apr. 26-Sept. 15 June 14-Sept. 15 June 23-Sept. 15 Apr. 26-Sept. 8 May 17-Sept. 15 May 24- Sept. 15 May 31-Sept. 15 June 1- Sept. 2 Apr. 1-Sept. 7; June 7-Mar. 31 Apr.1-Apr. 24; June 7-Sept. 7 and Dec. 1-Mar. 31	2(2)	3(3) 4(4)	None	None between 35 cm and 50 cm Minimum 40 cm Minimum 50 cm
Saskatchewan	Yes	May 4-Mar. 31 May 18-Mar. 31 May 25-Apr. 15 May 4-Sept. 10; Nov. 11-Mar. 31 May 25-Sept. 10; Nov. 11-Apr. 15	4(4)	2(2) 1(1) 2(4)	Only 1 over 65 cm	None over 65 cm
Yukon	Yes	None	3(6)	2(2) 1(1) 0(0)	Only 1 over 65 cm (includes possession) None under 20 cm	None between 65 cm and 100 cm and only 1 over 100 cm (includes possession) None over 65 cm
United States						
Alabama	No	-	-	-	-	-
Alaska	Yes	All Year Flowing waters – June 11-May 1 June 15-Apr. 14	4(4) 2(2)	1(1) +20" 2(2) -20" 10(10)	None	Minimum 26" Minimum 18" Minimum 24" None under 24" and only 1 over 24"
Arizona	No	-	-	-	-	-

Jurisdiction	Lake trout Present?	Open Season	Catch(Possession) Limits		Size Limits	
			Standard	Exception(s)	Standard	Exception(s)
Arkansas	No	-	-	-	-	-
California	Yes	July 1 - Sept. 30 All year	5(10)	2(2)	None	None
Colorado	Yes	All Year	4(8)	1(1) 8(8) 4(4) 2(2) 3(3)	None	None between 22 and 34" Only 1 over 20" Only 1 over 36" None between 26 and 36" Only 1 over 26"
Connecticut	Yes	3rd Saturday April-last day in Feb. All Year	5(5)*	2(2)* 1(1)	None	40.6 cm minimum 50.8 cm minimum 30.5-40.6 cm slot 1 fish over 40.6 cm
Delaware	Yes (introduced)	April 6-March 22	6(6)*	4(4)*	None	None
Florida	No	-	-	-	-	-
Georgia	No	-	-	-	-	-
Hawaii	No	-	-	-	-	-
Idaho	Yes	All Year (lakes/ponds) May 25-Nov. 30 (streams)	6(6)*	0(0) No limit 6(6)	None	None
Illinois	Yes	All Year	2(4)	None	25.4 cm minimum	None
Indiana	Yes	All Year (lakes/ponds)	2(4)	None	17.8 cm minimum	35.6 cm minimum
Iowa	No	-	-	-	-	-
Kansas	No	-	-	-	-	-
Kentucky	Yes	All Year	2(4)	None	None	55.8 cm minimum
Louisiana	No	-	-	-	-	-
Maine	Yes	April 1-September 30	2(2)*	1(1)	45.7 cm minimum	30.5 cm minimum only 1 over 30.5

Jurisdiction	Lake trout Present?	Open Season	Catch(Possession) Limits		Size Limits	
			Standard	Exception(s)	Standard	Exception(s)
Maryland	No	-	-	-	-	-
Massachusetts	Yes	All Year	3(3)	5(5)	None	4 of 5 less than 50.8 cm 1 of 5 greater than 50.8 cm none between 50.8 cm and 58.4 cm
Michigan	Yes	All Year Last Sat. in Apr.-Sept. 30	5(5)* (no more than 2 of any species and no more than 3 greater than 38.1 cm)	1(1) 2(2)	38.1 cm minimum	20.3 cm minimum 25.4 cm minimum 60.9 cm minimum
Minnesota	Yes	May 11-Sept. 30 Jan. 18-Mar. 16, 2003 Jan. 4-Mar. 31, 2003 Lake Superior Tributaries Dec. 1- Sept. 30, 2003	2(2)	3(3)	None	None
Mississippi	No	-	-	-	-	-
Missouri	No	-	-	-	-	-
Montana	Yes	All Year (lakes and reservoirs) 3rd Sat. in May-Nov. 30 (streams and rivers)	10(10) - western 3(3) - central and eastern	15(15) 5(5)*	None	None
Nebraska	No	-	-	-	-	-
Nevada	Yes	All Year	10(10)*	5(5)*	None	35.6 cm minimum
New Hampshire	Yes	Apr. 1-Sept. 30 Jan. 1-Mar. 31 Jan. 1-Sept. 30 (streams)	2(2)*	2(2)	45.7 cm minimum	38.1 cm minimum
New Jersey	Yes	Jan. 1-March 25; April 13-Dec. 31 Jan. 1-Sept. 15; Dec. 1-Dec. 31	4(4)*	6(6)* 1(1) 2(2)* 3(3)	17.8 cm minimum	38.1 cm minimum 50.8 cm minimum
New Mexico	Yes	All Year	5(10)*	1(1)* 2(2)* 3(3)*	None	50.8 cm minimum 40.6 cm minimum 38.1 cm minimum 30.5 cm minimum

Jurisdiction	Lake trout Present?	Open Season	Catch(Possession) Limits		Size Limits	
			Standard	Exception(s)	Standard	Exception(s)
New York	Yes	Apr. 1-Oct. 15 All Year Jan 1-Sept. 30 Apr. 1-Dec. 31	5(5)	1(1) 3(3) 3(3)* 2(2)	None	22.9 cm minimum None between 63.5 cm and 76.2 cm 38.1 cm minimum 53.3 cm minimum 45.7 cm minimum 58.4 cm minimum
North Carolina	No	-	-	-	-	-
North Dakota	Yes	All Year	3(6)	-	None	-
Ohio	No	-	-	-	-	-
Oklahoma	No	-	-	-	-	-
Oregon	Yes	All Year (lakes) May 25-Oct. 31 (streams)	5(10)*	-	20.3 cm minimum (only 1 fish over 50.8 cm daily)	-
Pennsylvania	Yes	April 12-September 1	2(2)	None	22.9 cm minimum	38.1 minimum
Rhode Island	No	-	-	-	-	-
South Dakota	No	-	-	-	-	-
Tennessee	Yes	All Year	2(2)	7(14)*	None	55.9 cm minimum none between 40.6 cm and 55.9 cm only 1 over 55.9 cm 35.6 cm minimum
Texas	No	-	-	-	-	-
Utah	Yes	All Year	2(2)		None	Only 1 greater than 71 cm Only 1 greater than 50.8 cm
Vermont	Yes	2nd Sat. in Apr. - last Sun. in Oct. All Year 3rd Sat. in Jan-2nd Sun. in Mar.	2(2)	3(3) 1(1)	45.7 cm minimum	38.1 cm minimum 50.8 cm minimum

			Catch (Possession) Limits		Size Limits	
Jurisdiction	Lake trout Present?	Open Season	Standard	Exception	Standard	Exception
Virginia	No	-	-	-	-	-
Washington	Yes	All Year Aug. 1-Mar. 31	2(4)	5(10)* No limit	20.3 cm minimum	None
West Virginia	No	-	-	-	-	-
Wisconsin	Yes	Mar. 1-Oct. 31 All Year Dec. 1-Sept. 30 May 3-Sept. 30 Jan. 4-Sept. 30	2(2)	0(0) 3(3) 1(1)	25.4 cm minimum	Only one greater than 63.5 cm 66 cm minimum 43.2 cm minimum 76.2 cm minimum
Wyoming	Yes	All Year	6(6)*	2(2) 4(4)	1 fish> 50.8 cm	Only one greater than 50.8 cm Only one greater than 71 cm None between 40.6 cm and 66 cm

Legend
*Trout aggregate

References

Scott, W. B. and E. J. Crossman. Freshwater Fishes of Canada. Fisheries Research Board of Canada. Ottawa, Ontario. 966 p.

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